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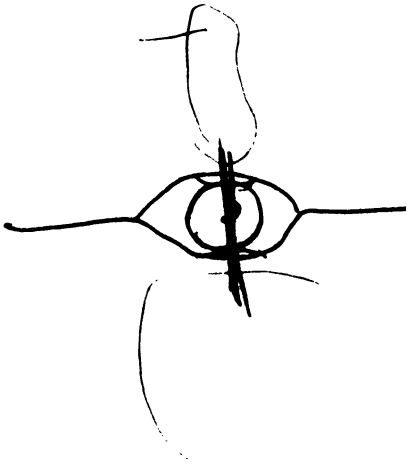

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THE

POPULAR SCIENCE MONTHLY.

MAY, 1890.

EDWARD LIVINGSTON YOUMANS:*

THE MAN AND HIS WORK.

By JOHN FISKE.

IN one of the most beautiful of all the shining pages of his History of the Spanish Conquest in America, Sir Arthur Helps describes the way in which, through "some fitness of the season, whether in great scientific discoveries or in the breaking into light of some great moral cause, the same processes are going on in many minds, and it seems as if they communicated with each other invisibly. We may imagine that all good powers aid the 'new light,' and brave and wise thoughts about it float aloft in the atmosphere of thought as downy seeds are borne over the fruitful face of the earth" (vol. iii, page 113). The thinker who elaborates a new system of philosophy deeper and more comprehensive than any yet known to mankind, though he may work in solitude, nevertheless does not work alone. The very fact which makes his great scheme of thought a success and not a failure is the fact that it puts into definite and coherent shape the ideas which many people are more or less vaguely and loosely entertaining, and that it carries to a grand and triumphant conclusion processes of reasoning in which many persons have already begun taking the earlier steps. This community in mental trend between the immortal discoverer and many of the brightest contemporary minds, far from diminishing the originality of his work, constitutes the feature of it which makes it a permanent acquisition for mankind, and distinguishes it from the eccentric philosophies which now and then come up to startle the world for a while, and are presently discarded and forgotten. The his-

* An Address before the Brooklyn Ethical Association, March 23, 1890.

tory of modern physics—as in the case of the correlation of forces and the undulatory theory of light—furnishes us with many instances of wise thoughts floating like downy seeds in the atmosphere until the moment has come for them to take root. And so it has been with the greatest achievement of modern thinking—the doctrine of evolution. Students and investigators in all departments, alike in the physical and in the historical sciences, were fairly driven by the nature of the phenomena before them into some hypothesis, more or less vague, of gradual and orderly change or development. The world was ready and waiting for Herbert Spencer's mighty work when it came, and it was for that reason that it was so quickly triumphant over the old order of thought. The victory has been so thorough, swift, and decisive that it will take another generation to narrate the story of it so as to do it full justice. Meanwhile, people's minds are apt to be somewhat dazed with the rapidity and wholesale character of the change; and nothing is more common than to see them adopting Mr. Spencer's ideas without recognizing them as his or knowing whence they got them. As fast as Mr. Spencer could set forth his generalizations they were taken hold of here and there by special workers, each in his own department, and utilized therein. His general system was at once seized, assimilated, and set forth with new illustrations by serious thinkers who were already groping in the regions of abstruse thought which the master's vision pierced so clearly. And thus the doctrine of evolution ha come to be inseparably interfused with the whole mass of thinking in our day and generation. I do not mean to imply that p ple commonly entertain very clear ideas about it, for clear i are not altogether common. I suspect that a good many p would hesitate if asked to state exactly what Newton's l gravitation is.

Among the men in America whose minds, between thir forty years ago, were feeling their way toward some such conception of nature as Mr. Spencer was about to set fort its dazzling glory—among the men who were thus prep grasp the doctrine of evolution at once and expound it wi illustrations—the first in the field was the man to whose we have met here this evening to pay a brief word of tri is but a little while since that noble face was here with u tones of that kindly voice were fraught with good che To most of you, I presume, the man Edward Livingsto is still a familiar presence. There must be many her ing who listened to the tidings of his death two years sense of personal bereavement. No one who knew hi ever to forget him. But for those who remembe the man it may not be superfluous to recount the

cidents of his life and work. It is desirable that the story should be set forth concisely, so as to be remembered; for the work was like the man, unselfish and unobtrusive, and in the hurry and complication of modern life such work is liable to be lost from sight, so that people profit by it without knowing that such work was ever done. So genuinely modest, so utterly destitute of self-regarding impulses was our friend, that I believe it would be quite like him to chide us for thus drawing public attention to him, as he would think, with too much emphasis. But such mild reproof it is right that we should disregard; for the memory of a life so beautiful and useful is a precious possession of which mankind ought not to be deprived.

EDWARD LIVINGSTON YOUMANS was born in the town of Coeymans, Albany County, N. Y., on the 3d of June, 1821. From his father and mother, both of whom survived him, he inherited strong traits of character as well as an immense fund of vital energy, such that the failure of health a few years ago seemed (to me, at least) surprising. His father, Vincent Youmans, was a man of independent character, strong convictions, and perfect moral courage, with a quick and ready tongue, in the use of which earnestness and frankness perhaps sometimes prevailed over prudence. The mother, Catherine Scofield, was notable for balance of judgment, prudence, and tact. The mother's grandfather was Irish; and, while I very much doubt the soundness of the generalizations we are so prone to make about race characteristics, I can not but feel that for the impulsive—one had almost said explosive—warmth of sympathy, the enchanting grace and vivacity of manner, in Edward Youmans, this strain of Irish blood may have been to some extent accountable. Both father and mother belonged to the old Puritan stock of New England, and the father's ancestry was doubtless purely English. Nothing could be more honorably or characteristically English than the name. In the old feudal society the *yeoman*, like the *franklin*, was the small freeholder, owning a modest estate yet holding it by no servile tenure, a man of the common people yet no churl, a member of the state who "knew his rights and knowing dared maintain." Few indeed were the nooks and corners outside of merry England where such men flourished as the yeomen and franklins who founded democratic New England. It has often been remarked how the most illustrious of Franklins exemplified the typical virtues of his class. There was much that was similar in the temperament and disposition of Edward Youmans—the sagacity and penetration, the broad common sense, the earnest purpose veiled but not hidden by the blithe humor, the devotion to ends of wide practical value, the habit of making in the best sense the most out of life.

When Edward was but six months old, his parents moved to Greenfield, near Saratoga Springs. With a comfortable house and three acres of land, his father kept a wagon-shop and smithy. In those days, while it was hard work to wring a subsistence out of the soil or to prosper upon any of the vocations which rural life permitted, there was doubtless more independence of character and real shiftiness than in our time, when cities and tariffs have so sapped the strength of the farming country. In the family of Vincent Youmans, though rigid economy was practiced, books were reckoned to a certain extent among the necessaries of life, and the house was one in which neighbors were fond of gathering to discuss questions of politics or theology, social reform or improvements in agriculture. On all such questions Vincent Youmans was apt to have ideas of his own; he talked with enthusiasm, and was also ready to listen; and he evidently supplied an intellectual stimulus to the whole community. For a boy of bright and inquisitive mind listening to such talk is no mean source of education. It often goes much further than the reading of books. From an early age Edward Youmans seems to have appropriated all such means of instruction. He had that insatiable thirst for knowledge which is one of God's best gifts to man; for he who is born with this appetite must needs be grievously ill-made in other respects if it does not constrain him to lead a happy and useful life.

After ten years at Greenfield the family moved to a farm at Milton, some two miles distant. Until his sixteenth year Edward helped his father at farm-work in the summer and attended the district school in winter. It was his good fortune for some time to fall into the hands of a teacher who had a genius for teaching —a man who in those days of rote-learning did not care to have things learned by heart, but sought to stimulate the thinking powers of his pupils, and who in that age of canes and ferules never found it necessary to use such means of discipline, because the fear of displeasing him was of itself all-sufficient. Experience of the methods of such a man was enough to sharpen one's disgust for the excessive mechanism, the rigid and stupid manner of teaching, which characterize the ordinary school. In after-years Youmans used to say that "Uncle Good"—as this admirable pedagogue was called—first taught him what his mind was for. Through intercourse and training of this sort he learned to doubt, to test the soundness of opinions, to make original inquiries, and to find and follow clews.

But even the best of teachers can effect but little unless he finds a mind ready of itself to take the initiative. It is doubtful if men of eminent ability are ever made so by schooling. The school offers opportunities, but in such men the tendency to the

initiative is so strong that if opportunities are not offered they will somehow contrive to create them. When Edward Youmans was about thirteen years old he persuaded his father to buy him a copy of Comstock's Natural Philosophy. This book he studied at home by himself, and repeated many of the experiments with apparatus of his own contriving. When he made a centrifugal water-wheel, and explained to the men and boys of the neighborhood the principle of its revolution in a direction opposite to that of the stream which moved it, we may regard it as his earliest attempt at giving scientific lectures. It was natural that one who had become interested in physics should wish to study chemistry. The teacher (who was not "Uncle Good") had never so much as laid eyes on a text-book of chemistry; but Edward was not to be daunted by such trifles. A copy of Comstock's manual was procured, another pupil was found willing to join in the study, and this class of two proceeded to learn what they could from reading the book, while the teacher asked them the printed questions—those questions the mere existence of which in text-books is apt to show what a low view publishers take of the average intelligence of teachers! It was not a very hopeful way of studying such a subject as chemistry; but doubtless the time was not wasted, and the foundations for a future knowledge of chemistry were laid. The experience of farm-work which accompanied these studies explains the interest which in later years Mr. Youmans felt in agricultural chemistry. He came to realize how crude and primitive are our methods of making the earth yield its produce, and it was his opinion that, when men have once learned how to conduct agriculture upon sound scientific principles, farming will become at once the most wholesome and the most attractive form of human industry.

Along with the elementary studies in science there went a great deal of miscellaneous reading, mostly, it would appear, of good solid books. Apparently there was at that time no study of languages, ancient or modern. At the age of seventeen the young man had shown so much promise that it was decided he should study law, and he had already entered upon a more extensive course of preparation in an academy in Saratoga County when the event occurred which changed the whole course of his life. He had been naturally gifted with keen and accurate vision, was a good sportsman and an excellent shot with a rifle, but at about the age of thirteen there had come an attack of ophthalmia which left the eyes weak and sensitive. Perpetual reading probably increased the difficulty and hindered complete recovery. At the age of seventeen violent inflammation set in, the sight in one eye was completely lost, while in the other it grew so dim as to be of little avail. Sometimes he would be just able to find his way about the

streets, at other times the blindness was almost total, and this state of things lasted for nearly thirteen years.

This dreadful calamity seemed to make it impossible to continue any systematic course of study, and the outlook for satisfactory work of any sort was extremely discouraging. The first necessity was medical assistance, and in quest of this Mr. Youmans came in the autumn of 1839 to New York, where for the most part he spent the remainder of his life. Until 1851 he was under the care of an oculist. Under such circumstances, if a man of eager energy and boundless intellectual craving were to be overwhelmed with despondency, we could not call it strange. If he were to become dependent upon friends for the means of support, it would be ungracious if not unjust to blame him. But Edward Youmans was not made of the stuff that acquiesces in defeat. He rose superior to calamity, he won the means of livelihood, and in darkness entered upon the path to an enviable fame. At first he had to resign himself to spending weary weeks over tasks that with sound eye-sight could have been dispatched in as many days. He invented some kind of writing-machine which held his paper firmly and enabled his pen to follow straight lines at proper distances apart. Long practice of this sort gave his handwriting a peculiar character which it retained in later years. When I first saw it in 1863 it seemed almost undecipherable; but that was far from being the case, and, after I had grown used to it, I found it but little less legible than the most beautiful c rography. The strokes, gnarled and jagged as they were, ha method in their madness, and every pithy sentence went strai as an arrow to its mark.

While conquering these physical obstacles Mr. Youmans b writing for the press, and gradually entered into relations leading newspapers which became more and more importan useful as years went on. He became acquainted with H Greeley, William Henry Channing, and other gentlem were interested in social reforms. His sympathies were enlisted with the little party of abolitionists, then held scornful disfavor by all other parties. He was also inte the party of temperance, which, as he and others were to learn, compounded for its essential uprightness of p indulging in very gross intemperance of speech and ac disinterestedness which always characterized him was by his writing many articles for a temperance paper w not afford to pay its contributors, although he was with such disadvantages in earning his own livelihoo ing on his scientific studies. Those were days when formers believed that by some cunningly contrived social arrangements our human nature, with all i

from countless ages of brutality, can somehow be made over all in a moment, just as one would go to work with masons and carpenters and revamp a house. There are many good people who still labor under such a delusion.

Though Mr. Youmans was brought into frequent contact with reformers of this sort, it does not seem to me that his mind was ever deeply impressed with such ways of thinking. Science is teaching us that the method of evolution is that mill of God, of which we have heard, which, while it grinds with infinite efficacy, yet grinds with wearisome slowness. It was Mr. Darwin's discovery of natural selection which first brought this truth home to us; but Sir Charles Lyell had in 1830 shown how enormous effects are wrought by the cumulative action of slight and unobtrusive causes, and this had much to do with turning men's minds toward some conception of evolution. It was about 1847 that Mr. Youmans was deeply interested in the work of geologists, as well as in the nebular theory, to which recent discoveries were adding fresh confirmation. Some time before this he had read that famous book, Vestiges of Creation, and, although Prof. Agassiz truly declared that it was an unscientific book crammed with antiquated and exploded fancies, I suspect that Mr. Youmans felt that amid all the chaff there was a very sound and sturdy kernel of truth.

Among the books which Mr. Youmans projected at this time, the first was a compendious history of progress in discovery and invention; but, after he had made extensive preparations, a book was published so similar in scope and treatment that he abandoned the undertaking. Another work was a treatise on arithmetic, on a new and philosophical plan; but, when this was approaching completion, he again found himself anticipated, this time by the book of Horace Mann. This was discouraging enough, but a third venture resulted in brilliant success. We have observed the eagerness with which, as a school-boy, Mr. Youmans entered upon the study of chemistry. His interest in this science grew with years, and he devoted himself to it so far as was practicable. For a blind man to carry on the study of a science which is preeminently one of observation and experiment might seem hopeless. It was at any rate absolutely necessary to see with the eyes of others if not with his own. Here the assistance rendered by his sister was invaluable. During most of this period she served as amanuensis and reader for him. But, more than this, she kept up for some time a course of laboratory work, the results of which were minutely described to her brother and discussed with him in the evenings. The lectures of Dr. John William Draper on chemistry were also thoroughly discussed and pondered.

The conditions under which Mr. Youmans worked made it

necessary for him to consider every point with the extreme deliberation involved in framing distinct mental images of things and processes which he could not watch with the eye. It was hard discipline, but he doubtless profited from it. Nature had endowed him with an unusually clear head, but this enforced method must have made it still clearer. One of the most notable qualities of his mind was the absolute luminousness with which he saw things and the relations among things. It was this quality that made him so successful as an expounder of scientific truths. In the course of his pondering over chemical facts which he was obliged to take at second hand, it occurred to him that most of the pupils in common schools who studied chemistry were practically no better off. It was easy enough for schools to buy text-books, but difficult for them to provide laboratories and apparatus; and it was much easier withal to find teachers who could ask questions out of a book than those who could use apparatus if provided. It was customary, therefore, to learn chemistry by rote; or, in other words, pupils' heads were crammed with unintelligible statements about things with queer names—such as manganese or tellurium—which they had never seen, and would not know if they were to see them. It occurred to Mr. Youmans that, if visible processes could not be brought before pupils, at any rate the fundamental conceptions of chemistry might be made clear by means of diagrams. He began devising diagrams in different colors, to illustrate the diversity in the atomic weights of the principal elements, and the composition of the more familiar compounds. At length, by uniting his diagrams, he obtained a comprehensive chart exhibiting the outlines of the whole scheme of chemical combination according to the binary or dualist theory then in vogue. This chart, when published, was a great success. It not only facilitated the acquirement of clear ideas, but it was suggestive of new ideas. It proved very popular, and kept the field until the binary theory was overthrown by the modern doctrine of substitution, which does not lend itself so readily to graphic treatment.

The success of the chemical chart led to the writing of a text-book of chemistry. This laborious work was completed in 1851, when Mr. Youmans was thirty years old. Prof. Silliman was then regarded as one of our foremost authorities in chemistry, but it was at once remarked of the new book that it showed quite as thorough a mastery of the whole subject of chemical combination as Silliman's. It was a text-book of a kind far less common then than now. There was nothing dry about it. The subject was presented with beautiful clearness, in a most attractive style. There was a firm grasp of the philosophical principles underlying chemical phenomena, and the meaning and functions of the sci-

ence were set forth in such a way as to charm the student and make him wish for more. The book had an immediate and signal success; in after-years it was twice rewritten by the author, to accommodate it to the rapid advances made by the science, and it is still one of our best text-books of chemistry. It has had a sale of about one hundred and fifty thousand copies.

The publication of this book at once established its author's reputation as a scientific writer, and in another way it marked an era in his life. The long, distressing period of darkness now came to an end. Sight was so far recovered in one eye that it became possible to go about freely, to read, to recognize friends, to travel, and make much of life. I am told that his face had acquired an expression characteristic of the blind, but that expression was afterward completely lost. When I knew him it would never have occurred to me that his sight was imperfect, except perhaps as regards length of range.

Mr. Youmans's career as a scientific lecturer now began. His first lecture was the beginning of a series on the relations of organic life to the atmosphere. It was illustrated with chemical apparatus, and was given in a private room in New York to an audience which filled the room. Probably no lecturer ever faced his first audience without some trepidation, and Mr. Youmans had not the main-stay and refuge afforded by a manuscript, for his sight was never good enough to make such an aid available for his lectures. At first the right words were slow in finding their way to those ready lips, and his friends were beginning to grow anxious, when all at once a happy accident broke the spell. He was remarking upon the characteristic instability of nitrogen, and pointing to a jar of that gas on the table before him, when some fidgety movement of his knocked the jar off the table. He improved the occasion with one of his quaint *bons mots*, and, as there is nothing that greases the wheels of life like a laugh, the lecture went on to a successful close.

This was the beginning of a busy career of seventeen years of lecturing, ending in 1868; and I believe it is safe to say that few things were done in all those years of more vital and lasting benefit to the American people than this broadcast sowing of the seeds of scientific thought in the lectures of Edward Youmans. They came just at the time when the world was ripe for the doctrine of evolution, when all the wondrous significance of the trend of scientific discovery since Newton's time was beginning to burst upon men's minds. The work of Lyell in geology, followed at length in 1859 by the Darwinian theory; the doctrine of the correlation of forces and the consequent unity of nature; the extension and reformation of chemical theory; the simultaneous advance made in sociological inquiry, and in the conception of the

true aims and proper methods of education—all this made the period a most fruitful one for the peculiar work of such a teacher as Youmans. The intellectual atmosphere was charged with conceptions of evolution. Mr. Youmans had arrived at such conceptions in the course of his study of the separate lines of scientific speculation which were now about to be summed up and organized by Herbert Spencer into that system of philosophy which marks the highest point to which the progressive intelligence of mankind has yet attained. In the field of scientific generalization upon this great scale, Mr. Youmans was not an originator; but his broadly sympathetic and luminous mind moved on a plane so near to that of the originators that he seized at once upon the grand scheme of thought as it was developed, made it his own, and brought to its interpretation and diffusion such a happy combination of qualities as one seldom meets with. The ordinary popularizer of great and novel truths is a man who comprehends them but partially and illustrates them in a lame and fragmentary way. But it was the peculiarity of Mr. Youmans that, while on the one hand he could grasp the newest scientific thought so surely and firmly that he seemed to have entered into the innermost mind of its author, on the other hand he could speak to the general public in a convincing and stimula
ing way that had no parallel. This was the secret of his powe
and there can be no question that his influence in educating t
American people to receive the doctrine of evolution was gr
and wide-spread.

The years when Mr. Youmans was traveling and lectu
were the years when the old lyceum system of popular lec
was still in its vigor. The kind of life led by the energeti
urer in those days was not that of a Sybarite, as may be see
a passage in one of his letters: "I lectured in Sandusky,
to get up at five o'clock to reach Elyria; I had had but v
sleep. To get from Elyria to Pittsburg I must take the fiv
morning train, and the hotel darkey said he would *try* t
me. I knew what that meant, and so did not get a sing
sleep that night. Rode all day to Pittsburg, and had
in the great Academy of Music over foot-lights. . . .
that left for Zanesville departed at two in the morni
been assured a hundred times (for I asked everybody
I would get a sleeping-car to Zanesville, and, whe
ready to start, I was informed that *this* morning th
sleeping-car. By the time I reached here I was pretty
used up."

Such a fatiguing life, however, has its compe
brings the lecturer into friendly contact with the bri
among his fellow-countrymen in many and many

larges his sphere of influence in a way that is not easy to estimate. Clearly an earnest lecturer, of commanding intelligence and charming manner, with a great subject to teach, must have an opportunity for sowing seeds that will presently ripen in a change of opinion or sentiment, in an altered way of looking at things on the part of whole communities. No lecturer has ever had a better opportunity of this sort than Edward Youmans, and none ever made a better use of his opportunity. His gifts as a talker were of the highest order. The commonest and plainest story, as told by Edward Youmans, had all the breathless interest of the most thrilling romance. Absolutely unconscious of himself, simple, straightforward, and vehement, wrapped up in his subject, the very embodiment of faith and enthusiasm, of heartiness and good cheer, it was delightful to hear him. And when we join with all this his unfailing common sense, his broad and kindly view of men and things, and the delicious humor that kept flashing out in quaint, pithy phrases such as no other man would have thought of, and such as are the despair of any one trying to remember and quote them, we can seem to imagine what a power he must have been with his lectures.

When such a man goes about for seventeen years, teaching scientific truths for which the world is ripe, we may be sure that his work is great, albeit we have no standard whereby we can exactly measure it. In hundreds of little towns with queer names did this strong personality appear and make its way and leave its effects in the shape of new thoughts, new questions, and enlarged hospitality of mind, among the inhabitants. The results of all this are surely visible to-day. In no part of the English world has Herbert Spencer's philosophy met with such a general and cordial reception as in the United States. This may, no doubt, be largely explained by a reference to general causes; but as it is almost always necessary, along with our general causes, to take into the account some personal influence, so it is in this case. It is safe to say that among the agencies which during the past fifty years have so remarkably broadened the mind of the American people, very few have been more potent than the gentle and subtle but pervasive work done by Edward Youmans with his lectures, and to this has been largely due the hospitable reception of Herbert Spencer's ideas.

It was in 1856 that Mr. Youmans fell in with a review of Spencer's Principles of Psychology, by Dr. Morell, in the Medico-Chirurgical Review. This review impressed him so deeply that he at once sent to London for a copy of the book, which had been published in the preceding year. It will be observed that this was four years before the Darwinian theory was announced to the world in the first edition of the Origin of Species. Toward the

end of that book Mr. Darwin looked forward to a distant future when the conception of gradual development might be applied to the phenomena of conscious intelligence. He had not then learned of the existence of such a book as the Principles of Psychology. In later editions he was obliged to modify his statement and confess that, instead of looking so far forward, he had better have looked about him. I have more than once heard Mr. Darwin laugh merrily over this, at his own expense.

After struggling for a while with the weighty problems of this book—the most profound treatise upon mental phenomena that any human mind has ever produced—Mr. Youmans saw that the theory expounded in it was a long stride in the direction of a general theory of evolution. His interest in this subject received a new and fresh stimulus. He read Social Statics, and began to recognize Mr. Spencer's hand in the anonymous articles in the quarterlies in which he was then announcing and illustrating various portions or segments of his newly discovered law of evolution. One evening in February, 1860, as Mr. Youmans was calling at a friend's house in Brooklyn, the Rev. Samuel Johnson, of Salem, handed him the famous prospectus of the great series of philosophical works which Mr. Spencer proposed to issue by subscription. Mr. Johnson had obtained this from Edward Silsbee, who was one of the very first Americans to become interested in Spencer. The very next day Mr. Youmans wrote a letter Mr. Spencer, offering his aid in procuring American subscriptio and otherwise aiding in every possible way the progress of t enterprise. With this letter and Mr. Spencer's cordial reply gan the life-long friendship between the two men. It was in same month that I first became aware of Mr. Spencer's exi through a single paragraph quoted from him by Mr. Lew in that paragraph there was immense fascination. I ha steeping myself in the literature of modern philosophy, s with Bacon and Descartes, and was then studying Comt losophie Positive, which interested me as suggesting that cial doctrines of the several sciences might be organize general body of doctrine of universal significance. Com was crude and often wildly absurd, but there was much was very suggestive. In May, 1860, in the Old Corner in Boston, I fell upon a copy of that same prospectus c cer's works, and read it with exulting delight, for c was to be such an organization of scientific doctrine a was waiting for. It appeared that there was some nor & Fields undertaking to conduct the series in c tions enough should be received. Mr. Spencer prefe his works appear in Boston; but when in the cour book on Education was offered to Ticknor & Fields

to publish it, which was, of course, a grave mistake from the business point of view. Mr. Youmans, however, was not sorry for this, for it gave him the opportunity to place Mr. Spencer's books where he could do most to forward their success.

Some years before, during his blindness, his sister had led him one day into the store of Messrs. D. Appleton & Co. in quest of a book, and Mr. William H. Appleton had become warmly interested in him. I believe the firm now look back to this chance visit as one of the most auspicious events in their annals. He became by degrees a kind of adviser as regarded matters of publication, and it was largely through his far-sighted advice that the Appletons entered upon the publication of such books as those of Buckle, Darwin, Huxley, Tyndall, Haeckel, and others of like character, always paying a royalty to the authors, the same as to American authors, in spite of the absence of an international copyright law. As publishers of books of this sort the Appletons have come to be pre-eminent. It is obvious enough nowadays that such books are profitable from a business point of view. But thirty years and more ago this was by no means obvious. We were very provincial. Reprints of English books, translations from French and German, were sadly behind the times. In the Connecticut town where I lived people would begin to wake up to the existence of some great European book or system of thought after it had been before the world anywhere from a dozen to fifty years. In those days, therefore, it required some boldness to undertake the reprinting of new scientific books, and none have recognized more freely than the Appletons the importance of the part played by Mr. Youmans in this matter. His work as adviser to a great publishing house and his work as lecturer re-enforced each other, and thus his capacity for usefulness was much increased.

When Mr. Spencer's book on Education failed to find favor in Boston, the Appletons took it, and thus presently secured the management of the philosophical series. This brought Mr. Youmans into permanent relations with Mr. Spencer and his work. In 1861 Mr. Youmans was married, and in the course of the following year made a journey in Europe with his wife. It was now that he became personally acquainted with Mr. Spencer, and found him quite as interesting and admirable as his books. Friendships were also begun with Huxley and other foremost men of science. From more than one of these men I have heard the warmest expressions of personal affection for Mr. Youmans, and of keen appreciation of the aid that they have obtained in innumerable ways from his intelligent and enthusiastic sympathy. But no one else got so large a measure of this support as Mr. Spencer. As fast as his books were republished, Mr. Youmans

wrote reviews of them, and by no means in the usual perfunctory way; his reviews and notices were turned out by the score, and scattered about in the magazines and newspapers where they would do the most good. Whenever he found another writer who could be pressed into the service, he would give him Spencer's books, kindle him with a spark from his own magnificent enthusiasm, and set him to writing for the press. The most indefatigable vender of wares was never more ruthlessly persistent in advertising for lucre's sake than Edward Youmans in preaching in a spirit of the purest disinterestedness the gospel of evolution. As long as he lived, Mr. Spencer had upon this side of the Atlantic an *alter ego* ever on the alert with vision like that of a hawk for the slightest chance to promote his interests and those of his system of thought.

Among the allies thus enlisted at that early time were Mr. George Ripley and Rev. Henry Ward Beecher, both of whom did good service, in their different ways, in awakening public interest in the doctrine of evolution. In those days of the civil war it was especially hard to keep up the list of subscribers in an abstruse philosophical publication of apparently interminable length. Mr. Youmans now and then found it needful to make a journey in the interests of the work, and it was on one of these occasions, in November, 1863, that I made his acquaintance. I had already published, in 1861, an article in one of the quarterly reviews in which Mr. Spencer's work was referred to; and another in 1863, in which the law of evolution was illustrated in connection with certain problems of the science of language. The articles were anonymous, as was then the fashion, and Mr. Youmans's curiosity was aroused. There were so few people then who had any conception of what Mr. Spencer's work meant, that they could have been counted on one's fingers. At that time I knew of only three —the late Prof. Gurney, of Harvard; Mr. George Roberts, now an eminent patent lawyer in Boston; and Mr. John Clark, now of the Prang Educational Company. I have since known that there were at least two or three others about Boston, among others, my learned friend the Rev. W. R. Alger, besides several in other parts of the country. When we sometimes ventured to observe that Mr. Spencer's work was as great as Newton's, and that his theory of evolution was going to remodel human thinking upon all subjects whatever, people used to stare at us and take us for idiots. Any one member of such a small community was easy to find; and I have always dated a new era in my life from the Sunday afternoon when Mr. Youmans came to my room in Cambridge. It was the beginning of a friendship such as hardly comes but once to a man. At that first meeting I knew nothing of him except that he was the author of a text-book of chemistry

which I had found interesting, in spite of its having been crammed down my throat by an old-fashioned memorizing teacher who, I am convinced, never really knew so much as the difference between oxygen and antimony. At first it was a matter of breathless interest to talk with a man who had seen Herbert Spencer. But one of the immediate results of this interview was the beginning of my own correspondence with Mr. Spencer, which led to manifold results. And from that time forth it always seemed as if, whenever any of the good or lovely things of life came to my lot, somehow or other Edward Youmans was either the cause of it or at any rate intimately concerned with it. The sphere of his unselfish goodness was so wide and its quality so potent that one could not come into near relations with him without becoming in all manner of unsuspected ways strengthened and enriched.

In the autumn of 1865 we were dismayed by the announcement that Mr. Spencer would no longer be able to go on issuing his works. In London they were published at his own expense and risk, and those books which now yield a handsome profit did not then pay the cost of making them. By the summer of 1865 there was a balance of £1,100 against Mr. Spencer, and his property was too small to admit of his going on and losing at such a rate. As soon as this was known, John Stuart Mill begged to be allowed to assume the entire pecuniary responsibility of continuing the publication; but this, Mr. Spencer, while deeply affected by such noble sympathy, would not hear of. He consented, however, with great reluctance, to the attempt of Huxley and Lubbock, and other friends, to increase artificially the list of subscribers by inducing people to take the work just in order to help support it. But after several months the sudden death of Mr. Spencer's father added something to his means of support, and he thereupon withdrew his consent to this arrangement, and determined to go on publishing as before, and bearing the loss.

But, as soon as the first evil tidings reached America, Mr. Youmans made up his mind that $5,500 must be forthwith raised by subscription, in order to make good the loss already incurred. It is delightful to remember the vigor with which he took hold of this work. The sum of $7,000 was raised and invested in American securities in Mr. Spencer's name. If he did not see fit to accept these securities, they would go without an owner. The best Waltham watch that could be procured was presented to Mr. Spencer by his American friends; a letter, worded with rare delicacy and tact, was written by the late Robert Minturn; and Mr. Youmans sailed for England to convey the letter and the watch to Mr. Spencer. It was a charming scene on a summer day in an English garden when the great philosopher was apprised of what had

been done. It was so skillfully managed that he could
the tribute without seeming churlish. He therefore
and applied it to extending his researches in descriptiv

Of the many visits which Mr. Youmans made to En
and then extending them to the Continent, one of the
tant was in 1871, for the purpose of establishing the In
Scientific Series. This was a favorite scheme of Mr.
He realized that popular scientific books, adapted to
reader, are apt to be written by third-rate men who
understand their subject; they are apt to be dry or su
both. No one can write so good a popular book as the
subject, if he only has a fair gift of expressing himself a
mind the public for which he is writing. The master k
to tell and what to omit, and can thus tell much in a
pass and still make it interesting; moreover, he avoids
racies which are sure to occur in second-hand work.
subjects are apt, however, to be too much occupied wi
research to write popular books. It was Mr. Youmar
induce the leading men of science in Europe and Amer
tribute small volumes on their special subjects to a
published simultaneously in several countries and
Furthermore, by special contract with publishing hou
reputation, the author was to receive the ordinary
every copy of his book sold in every one of the countr
tion, thus anticipating international copyright upon a
scale, and giving the author a much more adequate co
for his labor. To put this scheme into operation wa
great difficulty, so many conflicting interests had to
ered. Mr. Youmans's brilliant success is attested by
series of more than fifty volumes, on all sorts of scie
jects, written by men of real eminence, and published i
France, Italy, Germany, and Russia, as well as in t
States.

A word is all that can be spared for other parts of
work, which deserve many words and those carefully
His book on Household Science is not the usual co
scrappy comment, recipe, and apothegm, but a valu
tific treatise on heat, light, air, and food in their relatio
day life. In his Correlation of Physical Forces he brin
the epoch-making essays of the men who have successi
lished that doctrine, introducing them with an essay
in which its history and its philosophical implications
in a masterly manner. In his book on the Culture d
Modern Life we have a similar collection of essays
lar excellent original discussion, showing the need
later training in science, and protesting against the

and energy that is spent in classical education where it is merely the following of an old tradition.

As a crown to all this useful work Mr. Youmans established, in 1872, The Popular Science Monthly, which has unquestionably been of high educational value to the general public. It was not the aim of this magazine to give an account of every theory expounded, every fact observed, every discovery made from year to year, whether significant or insignificant. The mind of the people is not educated by dumping a great, unshapely mass of facts into it. It needs to be stimulated rather than crammed. Education in science should lead one to think for one's self. The scientific magazine, therefore, should present articles from all quarters that deal with the essential conceptions of science or discuss problems of real theoretical or practical interest, no matter whether every particular asteroid or the last new species of barnacle receives full attention or not. The Popular Science Monthly has now been with us eighteen years; its character has always been of the highest, and it must have exerted an excellent influence not only as a diffuser of valuable knowledge, but in training its readers to scientific habits of thought in so far as mere reading can contribute to such a result.

In concluding our survey of this useful and noble life, what impresses us most, I think, is the broad, democratic spirit and the absolute unselfishness which it reveals at every moment and in every act. To Edward Youmans the imperative need for educating the great mass of the people so as to use their mental powers to the best advantage came home as a living, ever-present fact. He saw all that it meant and means in the raising of mankind to a higher level of thought and action than that upon which they now live. To this end he consecrated himself with unalloyed devotion; and we who mourn his loss look back upon his noble career with a sense of victory, knowing how the good that such a man does lives after him and can never die.

[Mr. Fiske's address was followed by appreciative remarks from several gentlemen who had known Mr. Youmans, and who gave many interesting reminiscences of him. We append a letter from Mr. Spencer, which arrived too late to be read at this meeting.]

64 Avenue Road, Regent's Park, London, N. W., *March* 13, 1890.

Dear Mr. Skilton: I received your telegram last night, and from the wording conclude that you wish some letter from me about Youmans which Fiske may read in his lecture on the 23d. I am very glad to respond to the request, and I can not do this better than by giving you the following copy of a passage in my Autobiography concerning him:

"The relation thus initiated was extremely fortunate; for

Prof. Edward L. Youmans was, of all Americans I have known or heard of, the one most able and most willing to help me. Alike intellectually and morally, he had in the highest degrees the traits conducive to success in diffusing the doctrines he espoused; and from that time to this he has devoted his life mainly to spreading throughout the United States the doctrine of evolution. His love of wide generalizations had been shown years before in lectures on such topics as the correlation of the physical forces; and from those who heard him I have gathered that, aided by his unusual powers of exposition, the enthusiasm which contemplation of the larger truths of science produced in him was in a remarkable degree communicated to his hearers. Such larger truths I have on many occasions observed are those which he quickly seizes—ever passing at once through details to lay hold of essentials; and, having laid hold of them, he clearly sets them forth afresh in his own way with added illustrations. But it is morally even more than intellectually that he has proved himself a true missionary of advanced ideas. Extremely energetic—so energetic that no one has been able to check his overactivity—he has expended all his powers in advancing what he holds to be the truth; and not only his powers but his means. It has proved impossible to prevent him from injuring himself in health by his exertions; and it has proved impossible to make him pay due regard to his personal interests. So that toward the close of life he finds himself wrecked in body and impoverished in estate by thirty years of devotion to high ends. Among professed worshipers of humanity, who teach that human welfare should be the dominant aim, I have not yet heard of one whose sacrifices on behalf of humanity will bear comparison with those of my friend."

Though the volume containing this passage will not be published until after my death, I am very willing that this tribute of admiration to my late friend should be made public now.

I am, faithfully yours, HERBERT SPENCER.

A COMMITTEE of the British Association is charged with the collection of information respecting the disappearance or threatened disappearance of rare plants. While instances of complete extinction of any species within recent times may be rare, there are more of local extinction or of apparent extinction for a time, and the cases of threatened extinction are numerous enough to be alarming. A potent factor in the changes that have taken place is "the injudicious action of botanists themselves, and of botanical exchange clubs. The 'dealer' and 'collector' also figure largely in the process, while tourists are not responsible for much damage except indirectly by patronizing dealers. It is too often forgotten that the very rarity of a plant is the sign, and in great degree also the measure, of the acuteness of its struggle for existence, and that, when a plant is in unstable equilibrium with its environment, a small disturbance may have disproportionately great effects."

ON JUSTICE.

By HERBERT SPENCER.

[IN the January number of this Review* (page 126), I made the incidental statement that "should I be able to complete Part IV of the Principles of Ethics, treating of Justice, of which the first chapters only are at present written, I hope to deal adequately with these relations between the ethics of the progressive condition and the ethics of that condition which is the goal of progress—a goal ever to be recognized, though it can not be actually reached." These chapters were written nearly a year ago: the fourth, not quite finished, having been untouched since May last. In view of the possibility that the division of which they form part may never be completed, or otherwise that its completion may be long delayed, it has occurred to me that as the topic dealt with is now being discussed, these first chapters may, perhaps with advantage, be published forthwith. The editor having kindly assented to my proposal to issue them in this Review, I here append the first three: reserving two others, conveniently separable in subject-matter, for another article.]

I. ANIMAL-ETHICS.—Those who have not read the first division of this work† will be surprised by the above title. But the chapters on Conduct in General and The Evolution of Conduct will have shown to those who have read them that something which may be regarded as animal-ethics is implied.

It was there shown that the conduct which Ethics treats of is not separable from conduct at large; that the highest conduct is that which conduces to the greatest length, breadth, and completeness of life; and that by implication there is a conduct proper to each species of animal, which is the relatively good conduct—a conduct which stands toward that species as the conduct we morally approve stands toward the human species.

Most people regard the subject-matter of Ethics as being conduct considered as calling forth approbation or reprobation. But the primary subject-matter of Ethics is conduct considered objectively as producing good or bad results to self or others or both.

Even those who think of Ethics as concerned only with conduct which deserves praise or blame, tacitly recognize an animal-ethics; for certain acts of animals excite in them antipathy or sympathy. A bird which feeds its mate while she is sitting is regarded with a sentiment of approval. For a hen which refuses to

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* Nineteenth Century; also Popular Science Monthly for March, page 616.

† Reference is here made to the Data of Ethics.

sit upon her eggs there is a feeling of aversion; while one which fights in defense of her chickens is admired.

Egoistic acts, as well as altruistic acts, in animals are classed as good or bad. A squirrel which lays up a store of food for the winter is thought of as doing that which a squirrel ought to do; and, contrariwise, one which idly makes no provision and dies of starvation, is thought of as properly paying the penalty of improvidence. A dog which surrenders its bone to another without a struggle, and runs away, we call a coward—a word of reprobation.

Thus then it is clear that acts which are conducive to preservation of offspring or of the individual we consider as good relatively to the species, and conversely.

The two classes of cases of altruistic and egoistic acts of animals just given, exemplify the two cardinal and opposed principles of animal-ethics.

During immaturity benefits received must be inversely proportionate to capacities possessed. Within the family-group most must be given where least is deserved, if desert is measured by worth. Contrariwise, after maturity is reached, benefits must vary directly as worth: worth being measured by fitness to the conditions of existence. The ill fitted must suffer the evils of unfitness, and the well fitted profit by their fitness.

These are the two laws which a species must conform to if it is to be preserved. Limiting the proposition to the higher types (for in the lower types, parents give to offspring no other aid than that of laying up a small amount of nutriment with the germ; the result being that an enormous mortality has to be balanced by an enormous fertility)—thus limiting the proposition, I say, it is clear that if, among the young, benefit were proportioned to efficiency, the species would disappear forthwith; and if, among adults, benefit were proportioned to inefficiency, the species would disappear by decay in a few generations (see Principles of Sociology, section 322).

What is the ethical aspect of these principles? In the first place, animal life of all but the lowest kinds has been maintained by virtue of them. Excluding the *Protozoa*, among which their operation is scarcely discernible, we see that without *gratis* benefits to offspring, and earned benefits to adults, life could not have continued.

In the second place, by virtue of them life has gradually evolved into higher forms. By care of offspring which has become greater with advancing organization, and by survival of the fittest in the competition among adults which has become keener

with advancing organization, superiority has been perpetually fostered, and further advances caused.

On the other hand, it is true that to this self-sacrificing care for the young and this struggle for existence among adults, has been due the carnage and the death by starvation which have characterized the evolution of life from the beginning. It is also true that the processes consequent on conformity to these principles are responsible for the production of torturing parasites, which outnumber in their kinds all other creatures.

To those who take a pessimist view of animal-life in general, contemplation of these principles can of course yield only dissatisfaction. But to those who take an optimist view, or a meliorist view, of life in general, and who accept the postulate of hedonism, contemplation of these principles must yield greater or less satisfaction, and fulfillment of them must be ethically approved.

Otherwise considered, these principles are either, according to the current belief, expressions of the Divine will, or, according to the agnostic belief, indicate the mode in which works the Unknowable Power throughout the Universe; and in either case they have the warrant hence derived.

But here, leaving aside the ultimate controversy of pessimism *versus* optimism, it will suffice for present purposes to set out with a hypothetical postulate, and to limit it to a single species. If the preservation and prosperity of such species are to be desired, there inevitably emerge one most general conclusion and from it three less general conclusions.

The most general conclusion is that, in order of obligation, the preservation of the species takes precedence of the preservation of the individual. It is true that the species has no existence save as an aggregate of individuals; and it is true that, therefore, the welfare of the species is an end to be subserved only as subserving the welfares of individuals. But since disappearance of the species, implying disappearance of all individuals, involves absolute failure in achieving the end, whereas disappearance of individuals, though carried to a great extent, may leave outstanding such number as can, by continuance of the species, make subsequent fulfillment of the end possible; the preservation of the individual must, in a variable degree according to circumstances, be subordinated to the preservation of the species, where the two conflict. The resulting corollaries are these:

First, that among adults there must be conformity to the law that benefits received shall be directly proportionate to merits possessed: merits being measured by power of self-sustentation. For, otherwise, the species must suffer in two ways. It must suffer immediately by sacrifice of superior to inferior, which entails a

general diminution of welfare; and it must suffer remotely by furthering increase of the inferior and, by implication, hindering increase of the superior, and by a consequent general deterioration which, if continued, must end in extinction.

Second, that during early life, before self-sustentation has become possible, and also while it can be but partial, the aid given must be the greatest where the worth shown is the smallest—benefits received must be inversely proportionate to merits possessed: merits being measured by power of self-sustentation. Unless there are *gratis* benefits to offspring, unqualified at first and afterward qualified by decrease as maturity is approached, the species must disappear by extinction of its young. There is, of course, necessitated a proportionate self-subordination of adults.

Third, to this self-subordination entailed by parenthood has, in certain cases, to be added a further self-subordination. If the constitution of the species and its conditions of existence are such that sacrifices, partial or complete, of some of its individuals, so subserve the welfare of the species that its numbers are better maintained than they would otherwise be, then there results a justification for such sacrifices.

Such are the laws by conformity to which a species is maintained; and if we assume that the preservation of a particular species is a *desideratum*, there arises in it an obligation to conform to these laws, which we may call, according to the case in question, quasi-ethical or ethical.

II. Sub-Human Justice.—Of the two essential but opposed principles of action by pursuance of which each species is preserved, we are here concerned only with the second. Passing over the law of the family as composed of adults and young, we have now to consider exclusively the law of the species as composed of adults only.

This law we have seen to be that individuals of most worth measured by their fitness to the conditions of existence, shall h the greatest benefits, and that inferior individuals shall re smaller benefits, or suffer greater evils, or both results—which, under its biological aspect, has for its implication th vival of the fittest. Interpreted in ethical terms it is tha individual ought to be subject to the effects of its own natu resulting conduct. Throughout sub-human life this la without qualification; for there exists no agency by whic adults, the relations between conduct and consequence c terfered with.

Fully to appreciate the import of this law we may wi tage pause a moment to contemplate an analogous law; the same law as exhibited in another sphere. Besides played in the relations among members of the species,

ively well or ill sustained according to their well-adapted activities or ill-adapted activities, it is displayed in the relations of parts of each organism to one another.

Every muscle, every viscus, every gland, receives blood in proportion to function. If it does little it is ill-fed and dwindles; if it does much it is well-fed and grows. By this balancing of expenditure in action and payment in nutriment, there is, at the same time, a balancing of the relative powers of the parts of the organism; so that the organism as a whole is fitted to its existence by having the proportions of its parts continuously adjusted to the requirements. And clearly this principle of self-adjustment within each individual is parallel to that principle of self-adjustment by which the species as a whole keeps itself fitted to its environment. For by the better nutrition and greater power of propagation which come to members of the species that have faculties and consequent activities best adapted to the needs, joined with the lower sustentation of self and offspring which accompany less adapted faculties and activities, there is caused such special growth of the species as most conduces to its survival in face of surrounding conditions.

This, then, is the law of sub-human justice, that each individual shall receive the benefits and the evils of its own nature and its consequent conduct.

But sub-human justice is extremely imperfect, alike in general and in detail.

In general, it is imperfect in the sense that there exist multitudinous species the sustentation of which depends on the wholesale destruction of other species; and this wholesale destruction implies that the species serving as prey have the relations between conduct and consequence so habitually broken that in but very few individuals are they long maintained. It is true that in such cases the premature loss of life suffered from enemies by nearly all members of the species, must be considered as resulting from their natures—their inability to contend with the destructive agencies they are exposed to. But we may fitly recognize the truth that this violent ending of the immense majority of its lives, implies that the species is one in which justice, as above conceived, is displayed in but small measure.

Sub-human justice is extremely imperfect in detail, in the sense that the relation between conduct and consequence is in such an immense proportion of cases broken by accidents—accidents of kinds which fall indiscriminately upon inferior and superior individuals. There are the multitudinous deaths caused by inclemencies of weather, which, in the great majority of cases, the best members of the species are liable to like the worst. There are

other multitudinous deaths caused by scarcity of food, which, if not wholly, still in large measure, carries off good and bad alike. Among low types, too, enemies are causes of death which so operate that superior as well as inferior are sacrificed. And the like holds with invasions by parasites, often widely fatal. These attack, and frequently destroy, the most perfect individuals as readily as the least perfect.

The high rate of multiplication required to balance the immense mortality among low animals, at once shows us that among them long survival is not insured by superiority; and that thus the sub-human justice, which consists in continued receipt of the results of conduct, holds individually in but few cases.

And here we come upon a truth of great significance—the truth that sub-human justice becomes more decided as organization becomes higher.

Whether this or that fly is taken by a swallow, whether among a brood of caterpillars an ichneumon settles on this or that, whether out of a shoal of herrings this or that is swallowed by a cetacean, is an event quite independent of individual peculiarity: good and bad samples fare alike. With high types of creatures it is otherwise. Keen senses, sagacity, agility, give a particular carnivore special power to secure prey. In a herd of herbivorous creatures, the one with quickest hearing, clearest vision, most sensitive nostril, or greatest speed, is the one most likely to save itself.

Evidently, in proportion as the endowments, mental and bodily, of a species are high, and as, consequently, its ability to deal with the incidents of the environment is great, the continued life of each individual is less dependent on accidents against which it can not guard. And, evidently, in proportion as this result of general superiority becomes marked, the results of special superiorities are felt. Individual differences of faculty play larger parts in determining individual fates. Now deficiency of a power shortens life, and now a large endowment prolongs it. That is to say, individuals experience more fully the results of their own natures —the justice is more decided.

With creatures which lead solitary lives, the nature of sub-human justice is thus sufficiently expressed; but on passing to gregarious creatures, there enters into it a new element.

Simple association, as of sheep or deer, profits the individual and the species only by that more efficient safeguarding which results from the superiority of a multitude of eyes, ears, and noses over the eyes, ears, and nose of a single individual. Through the alarms more quickly given, all benefit by the senses of the most acute. Where this, which we may call passive co-operation, rises

into active co-operation, as among rooks where one of the flock keeps watch while the rest feed, or as among beavers where a number work together in making dams, or as among wolves where, by a plan of attack in which the individuals play different parts, prey is caught which would otherwise not be caught; there is still greater advantage to the individuals and to the species. And, speaking generally, we may say that gregariousness, and co-operation more or less active establish themselves in a species only because they are profitable to it; since, otherwise, survival of the fittest must prevent establishment of them.

But now mark that this profitable association is made possible only by observance of certain conditions. The acts directed to self-sustentation which each performs, are performed more or less in presence of others performing like acts; and there tends to result more or less interference. If the interference is great, it may render the association unprofitable. For the association to be profitable the acts must be restrained to such an extent as to leave a balance of advantage. Survival of the fittest will else exterminate that variety of the species in which association begins.

Here, then, we find a further factor in sub-human justice. Each individual, receiving the benefits and the injuries due to its own nature and consequent conduct, has to carry on that conduct subject to the restriction that it shall not in any large measure impede the conduct by which each other individual achieves benefits or brings on itself injuries. The average conduct must not involve aggressions of such amounts as to cause evils which outbalance the good obtained by co-operation. Thus, to the positive element in sub-human justice has to be added, among gregarious creatures, a negative element.

The necessity for observance of the condition that each member of the group while carrying on the pursuit of self-sustentation and sustentation of offspring, shall not seriously impede the like pursuits of others, makes itself so felt, where association is established, as to mold the species to it. The mischiefs from time to time experienced when the limits are transgressed, continually discipline all in such ways as to produce regard for the limits; so that such regard becomes, in course of time, a natural trait of the species. For, manifestly, regardlessness of the limits, if great and general, causes dissolution of the group. Those varieties only can survive as gregarious varieties in which there is an inherited tendency to maintain the limits.

Yet, further, there arises such general consciousness of the need for maintaining the limits, that punishments are inflicted on transgressors—not only by aggrieved members of the group, but by the group as a whole. A "rogue" elephant (always distin-

guished as unusually malicious) is one which has been expelled from the herd: doubtless because of conduct obnoxious to the rest —probably aggressive. It is said that from a colony of beavers an idler is banished, and thus prevented from profiting by labors in which he does not join: a statement made more credible by the fact that drones, when no longer needed, are killed by worker-bees. The testimonies of observers in different countries show that a flock of crows, after prolonged noise of consultation, will summarily execute an offending member. And an eye-witness affirms that among rooks, a pair which steals the sticks from neighboring nests has its own nest pulled to pieces by the rest.

Here, then, we see that the *a priori* condition to harmonious co-operation comes to be tacitly recognized as something like a law; and there is a penalty consequent upon breach of it.

That the individual shall experience all the consequences, good and evil, of its own nature and consequent conduct, which is that primary principle of sub-human justice whence results survival of the fittest, is, in creatures that lead solitary lives, a principle complicated only by the responsibilities of parenthood. Among them the purely egoistic actions of self-sustentation have, during the reproductive period, to be qualified by that self-subordination which the rearing of offspring necessitates, but by no other self-subordination. Among gregarious creatures of considerable intelligence, however, the welfare of the species occasionally demands a further self-subordination.

We read of bisons that, during the calving season, the bulls form an encircling guard around the herd of cows and calves, to protect them against wolves and other predatory animals: a proceeding which entails on each bull some danger, but which conduces to the preservation of the species. Out of a herd of elephants about to emerge from a forest to reach a drinking-place, one will first appear and look round in search of dangers, and, not discerning any, will then post some others of the herd to act as watchers; after which the main body comes forth and enters the water. Here a certain extra risk is run by the few that the many may be the safer. In a still greater degree we are shown this kind of action by a troop of monkeys, the members of which will combine to defend or rescue one of their number; for though in any particular case the species may not profit, since more mortality may result than would have resulted, yet it profits in the long run by the display of a character which makes attack on its groups dangerous.

Evidently, then, if by such conduct one variety of a gregarious species keeps up, or increases, its numbers, while other varieties, in which self-subordination thus directed does not exist, fail to do

this, a certain sanction is acquired for such conduct. The preservation of the species being the ultimate end, it results that where an occasional mortality of individuals in defense of the species furthers this preservation in a greater degree than would pursuit of exclusive benefit by each individual, that which we recognize as sub-human justice may rightly have this second limitation.

It remains only to point out the order of priority, and the respective ranges, of these principles. The law of relation between conduct and consequence, which, throughout the animal kingdom at large, brings prosperity to those individuals which are structurally best adapted to their conditions of existence, and which, under its ethical aspect, is expressed in the principle that each individual ought to receive the good and the evil which arises from its own nature, is the primary law holding of all creatures; and is applicable without qualification to creatures which lead solitary lives, save in that self-subordination needed among the higher of them for the rearing of offspring.

Among gregarious creatures, and in an increasing degree as they co-operate more, there comes into play a law, second in order of time and authority, that those actions through which, in fulfillment of its nature, the individual achieves benefits and avoids evils, shall be restrained by the need for non-interference with the like actions of associated individuals. A substantial respect for this law in the average of cases being the condition under which alone gregariousness can continue, it becomes an imperative law for creatures to which gregariousness is a benefit. But, obviously, this secondary law is simply a specification of that form which the primary law takes under the conditions of gregarious life; since, by asserting that in each individual the interactions of conduct and consequence must be restricted in the specified way, it tacitly reasserts that these interactions must be maintained in all other individuals.

Later in origin, and narrower in range, is the third law, that under conditions such that, by the occasional sacrifices of some members of a species, the species as a whole prospers, there arises a sanction for such sacrifices, and a consequent qualification of the law that each individual shall receive the benefits and evils of its own nature.

Finally, it should be observed that whereas the first law is absolute for animals in general, and whereas the second law is absolute for gregarious animals, the third law is relative to the existence of enemies of such kinds that, in contending with them, the species gains more than it loses by the sacrifice of a few members; and in the absence of such enemies this qualification imposed by the third law disappears.

III. HUMAN JUSTICE.—The contents of the last chapter foreshadow the contents of this. As, from the evolution point of view, human life must be regarded as a further development of sub-human life, it follows that from this same point of view, human justice must be a further development of sub-human justice. For convenience the two are here separately treated, but they are essentially of the same nature, and form parts of a continuous whole.

Of man, as of all inferior creatures, the law by conformity to which the species is preserved is that among adults the individuals best adapted to the conditions of their existence shall prosper most, and that individuals least adapted to the conditions of their existence shall prosper least—a law which, if uninterfered with, entails survival of the fittest, and spread of the most adapted varieties. And as before so here, we see that, ethically considered, this law implies that each individual ought to receive the benefits and the evils of his own nature and consequent conduct: neither being prevented from having whatever good his actions normally bring to him, nor allowed to shoulder off on to other persons whatever ill is brought to him by his actions.

To what extent such ill, naturally following from his actions, may be voluntarily borne by other persons, it does not concern us now to inquire. The qualifying effects of pity, mercy, and generosity, will be considered hereafter in the parts dealing with Negative Beneficence and Positive Beneficence. Here we are concerned only with pure justice.

The law thus originating, and thus ethically expressed, is obviously that which commends itself to the common apprehension as just. Sayings and criticisms daily heard imply a perception that conduct and consequence ought not to be dissociated. When, of some one who suffers a disaster, it is said—"He has no one to blame but himself," there is implied the belief that he has not any ground for complaint. The comment on one whose misjudgment or misbehavior has entailed evil upon him, that "he has made his own bed, and now he must lie in it," has behind it the conviction that this connection of cause and effect is proper. Similarly with the remark—"He got no more than he deserved." A kindred conviction is implied when, conversely, there results good instead of evil. "He has fairly earned his reward"; "He has not received due recompense"; are remarks indicating the consciousness that there should be a proportion between effort put forth and advantage achieved.

The truth that justice becomes more pronounced as organization becomes higher, which we contemplated in the last chapter, is further exemplified on passing from sub-human justice to

human justice. The degree of justice and the degree of organization simultaneously make advances. These are shown alike by the entire human race, and by its superior varieties as contrasted with its inferior.

We saw that a high species of animals is distinguished from a low species in the respect that since its aggregate suffers less mortality from destructive agencies, each of its members continues on the average for a longer time subject to the normal relation between conduct and consequence; and here we see that the human race as a whole, far lower in its rate of mortality than nearly all races of inferior kinds, usually subjects its members for much longer periods to the good and evil results of well-adapted and ill-adapted conduct. We also saw that as, among the higher animals, a greater average longevity makes it possible for individual differences to show their effects for longer periods, it results that the unlike fates of different individuals are to a greater extent determined by that normal relation between conduct and consequence which constitutes justice; and we here see that in mankind unlikenesses of faculty in still greater degrees, and for still longer periods, work out their effects in advantaging the superior and disadvantaging the inferior in the continuous play of conduct and consequence.

Similarly is it with the civilized varieties of mankind as compared with the savage varieties. A still further diminished rate of mortality implies that there is a relatively still larger proportion, the members of which, during long lives, gain good from well-adapted acts, and suffer evil from ill-adapted ones. While also it is manifest that both the greater differences of longevity among individuals, and the greater differences of social position, imply that in civilized societies more than in savage societies, differences of endowment and consequent differences of conduct are enabled to cause their appropriate differences of results, good or evil: the justice is greater.

More clearly in the human race than in lower races are we shown that gregariousness establishes itself because it profits the variety in which it arises, partly by furthering general safety and partly by facilitating sustentation. And we are shown that the degree of gregariousness is determined by the degree in which it thus subserves the interests of the variety. For where the variety is one of which the members live on wild food, they associate only in small groups: game and fruits widely distributed can support these only. But greater gregariousness arises where agriculture makes possible the support of a large number on a small area; and where the accompanying development of industries introduces many and various co-operations.

But that which was faintly indicated among lower beings is conspicuously displayed among human beings—that the advantages of co-operation can be had only by conformity to certain requirements which association imposes. The mutual hindrances liable to arise during the pursuit of their ends by individuals living in proximity, must be kept within such limits as to leave a surplus of advantage obtained by associated life. Some types of men, as the Abors, lead solitary lives, because their aggressiveness is such that they can not live together. And in view of this extreme case it is clear that though, in many primitive groups, individual antagonisms often cause quarrels, yet the groups are maintained because their members derive a balance of benefit—chiefly in greater safety. It is also clear that in proportion as communities become developed and their division of labor complex, the advantages of co-operation can be gained only by a still better maintenance of those limits to each man's activities necessitated by the simultaneous activities of others. This truth is illustrated by the unprosperous or decaying state of communities in which the aggressions of individuals on one another are so numerous and great as to prevent them from severally receiving the normal results of their actions.

The requirement that individual activities must be mutually restrained, which we saw is so felt among certain inferior gregarious creatures that they inflict punishments on those who do not duly restrain them, is a requirement which, more imperative among men, and more distinctly felt by them to be a requirement, causes a still more marked habit of inflicting punishments on offenders. Though in primitive groups it is commonly left to any one who is injured to revenge himself on the injurer, and though even in the societies of feudal Europe, the defending and enforcing of his claims was in many cases held to be each man's personal concern; yet there has ever tended to grow up such perception of the need for internal order, and such sentiment accompanying the perception, that infliction of punishments by the community as a whole, or by its established agents, has become habitual. And that a system of laws enacting restrictions on conduct and punishments for breaking them, is a natural product of hum life carried on under social conditions, is shown by the fact t among multitudinous nations composed of various types of m kind, similar actions, similarly regarded as trespasses, have b similarly forbidden.

Through all which sets of facts is manifested the truth, r nized practically if not theoretically, that each individual ca on the actions which subserve his life, and not prevented receiving their normal results good and bad, shall carry on actions under such restraints as are imposed by the carryin

kindred actions by other individuals, who have similarly to receive such normal results good and bad. And vaguely, if not definitely, this is seen to constitute what is called justice.

We saw that among inferior gregarious creatures, justice in its universal simple form, besides being qualified by the self-subordination which parenthood implies, and in some measure by the self-restraint necessitated by association, is in a few cases further qualified in a small degree by the partial or complete sacrifice of individuals made in defense of the species. And now in the highest gregarious creature we see that this further qualification of primitive justice assumes large proportions.

No longer as among inferior beings demanded only by the need for defense against enemies of other kinds, this further self-subordination is, among human beings, also demanded by the need for defense against enemies of the same kind. Having become the predominant inhabitants of the Earth, and having spread wherever there is food, men have come to be everywhere in one another's way; and the mutual enmities hence resulting, have made the sacrifices entailed by wars between groups, far greater than the sacrifices made in defense of the groups against inferior animals. It is doubtless true with the human race, as with lower races, that destruction of the group or the variety does not imply destruction of the species; and it therefore follows that such obligation as exists for self-subordination in the interests of the group or the variety, is an obligation of lower degree than is that of sustentation of offspring, without fulfillment of which the species must disappear, and of lower degree than the obligation to restrain actions within the limits imposed by social conditions, without fulfillment of which the group will dissolve. Still, it must be regarded as an obligation to the extent to which the maintenance of the species is subserved by the maintenance of each of its groups.

But the self-subordination thus justified, and in a sense rendered obligatory, is limited to that which is required for defensive war. Only because the preservation of the group as a whole conduces to preservation of its members' lives and their ability to pursue the objects of life, is there a reason for the sacrifice of some of its members; and this reason no longer exists when war is offensive instead of defensive.

It may, indeed, be contended that since offensive wars initiate those struggles between groups which end in the destruction of the weaker, offensive wars, furthering the peopling of the Earth by the stronger, subserve the interests of the race. But even supposing that the conquered groups always consisted of men having smaller mental or bodily fitness for war (which they do not; for

it is in part a question of numbers, and the smaller groups may consist of the more capable warriors), there would still be an adequate answer. It is only during the earlier stages of human progress that the development of strength, courage, and cunning, are of chief importance. After societies of considerable size have been formed and the subordination needed for organizing them produced, other and higher faculties become those of chief importance; and the struggle for existence carried on by force, does not always further the survival of the fittest. The fact that but for a mere accident Persia would have conquered Greece, and the fact that the Tartar hordes very nearly overwhelmed European civilization, show that offensive war can be trusted to subserve the interests of the race only when the capacity for a high social life does not exist, and that in proportion as this capacity develops, offensive war tends more and more to hinder, rather than to further, human welfare. In brief we may say that the arrival at a stage in which ethical considerations come to be entertained, is the arrival at a stage in which offensive war, by no means certain to further predominance of races fitted for a high social life, and certain to cause injurious moral reactions on the conquering as well as on the conquered, ceases to be justifiable; and only defensive war retains a quasi-ethical justification.

And here it is to be remarked that the self-subordination which defensive war involves, and the need for such qualification of the abstract principle of justice as it implies, belong to that transitional state necessitated by the physical-force-conflict of races; and that they must disappear when there is reached a peaceful state. That is to say, all questions concerning the extent of such qualifications pertain to what we distinguished as relative ethics; and are not recognized by that absolute ethics which is concerned with the principles of right conduct in a society formed of human beings fully adapted to social life.

This distinction I emphasize here because throughout succeeding chapters we shall find that recognition of it helps us to disentangle the involved problems of political ethics.—*Nineteenth Century.*

THE constantly receding character of the unexplained was illustrated by Dr. Burdon Sanderson, in his address at the British Association, by reference to the discovery of the cell, which seemed to be a very close approach to the mechanism of life; "but now we are striving to get even closer, with the same result. Our measurements are more exact, our methods finer; but these very methods bring us to close quarters with phenomena which, although within reach of exact investigation, are, as regards their essence, involved in a mystery which is the more profound the more it is brought into contact with the exact knowledge we possess of surrounding conditions."

SUMPTUARY LAWS AND THEIR SOCIAL INFLUENCE.*

By WILLIAM A. HAMMOND, M. D.

THERE are many persons who have what they conceive to be the good of their fellow-creatures so greatly at heart that, when they can not succeed in making them conform to a standard of right and wrong that they have set up for themselves, endeavor to accomplish their object by legal enactments. It is true they are very apt to do this under the fiction of insuring the public welfare; but it is none the less a fact, even if we admit the force of their alleged motive, that such laws as those to which I refer interfere with the personal liberty of those against whom they are aimed, and this to an extent incompatible with that degree of freedom of will and of action which is inseparable from the individual in all communities founded upon what we call liberty. Moreover, they are inquisitorial in their nature, and, what is perhaps a point of even still greater importance, they fail to accomplish the object in view; and being continually evaded on one pretext or another, tend to diminish that respect for the majesty of law which all well-ordered citizens should entertain.

The history of sumptuary laws, or laws tending to limit luxury and expense, shows how truly the remarks just made are founded on fact; and yet in all ages of the world such laws have been passed, to be disobeyed, held in contempt, remaining on the statute-book unenforced, and finally either passing into oblivion or being formally repealed. As we are apparently passing through a stage of our national existence in which sumptuary laws are making their appearance, it seemed to me that the Society for Medical Jurisprudence and State Medicine might very properly have its attention directed to the subject.

Among the first within our knowledge to provide by law for the regulation of the appetite, the taste, the affections, the dress, and the most minute details in the life of a citizen was Sparta. Sparta was a small country and its people were few; they were surrounded by powerful neighbors. The first principle instilled into the mind of every individual was, that the state had a claim upon him superior to that of parents or of any relational or social bond. He was from the very cradle trained for war; luxury, being regarded as incompatible with true manliness, was to be suppressed at all hazards. Foreigners, being liable to become a disturbing factor in the system of discipline enforced, were not allowed to enter Sparta; even the feeble children, as being unfit

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for war and liable to become burdens on the community, were put to death. Gold and silver were excluded, and the coinage was of iron. As far as possible the whole nation was fed alike. That the system was effectual in accomplishing the object that Lycurgus had in view, is probably true. It succeeded just as persecution succeeds when it is thorough and implacable. A half-hearted system of persecution not only fails in its object, but invariably advances the cause against which it is directed. If, for instance, we could kill all those who oppose us in our efforts to make matters accord with our own way of thinking, we should undoubtedly be triumphantly successful; but if we only killed a few of them, it would not be long before the number of the remainder would be so augmented that they would kill us.

Nowhere has the inefficacy of sumptuary laws been more thoroughly demonstrated than in Rome. There the dress, the food, the furniture of the houses, were attempted to be regulated by law after law, which were either openly or secretly disobeyed, and which eventually disappeared from the statute-books. The cost of entertainments was limited; the number of guests a person might have at his house was restricted. No woman was allowed to have more than half an ounce of gold, or to wear a dress of more than one color, or to ride in a carriage. In France, during the Celtic period, a law was passed that women should drink water only. In 1188 or thereabout no person was allowed to wear garments of vair, gray, zibeline, or scarlet color. No laced or slashed garments were allowed, and no one could have more than two courses at meals. In 1328 scarlet was only permitted to be worn by princes, knights, and women of high rank. The use of silver plate was prohibited except to certain high dignitaries; and women were frequently sent to prison in forties, fifties, and sixties at a time for wearing clothes above their rank. Even as late as the seventeenth century gold, as an ornament on carriages, buildings, and gloves, was prohibited.

In England, during the reign of Edward IV, cloth of gold or silk of a purple color was prohibited to all but members of the royal family. Lords were allowed to wear velvet, knights satin, and esquires and gentlemen camelet. None but noblemen were allowed to wear woolen clothes made out of England, or fur of sables, and no laborer, servant, or artificer might wear any cloth which cost more than two shillings a yard. In the year 1336 an act of Parliament was passed which I quote in full, as showing to what extremes law can go in the way of interfering with the interior life of the citizens:

"Whereas heretofore, through the excessive and over-many sorts of costly meats which the people of this Realm have used more than elsewhere, many mischiefs have happened to the

people of this Realm: for the great men by these excesses have been sore grieved, and the lesser people who only endeavor to imitate the great ones in such sorts of meats are much impoverished, whereby they are not able to aid themselves nor their liege lord in time of need as they ought, and many other evils have happened as well to their souls as to their bodies, our Lord the King, desiring the common profit as well of the great men as of the common people of his Realm, and considering the evils, grievances, and mischiefs aforesaid, by the common assent of the prelates, earls, barons, and other nobles of his said Realm and of the commons of the said Realm, hath ordained and established that no man, of what state or condition soever he be, shall cause himself to be served in his house or elsewhere, at dinner-meal or supper, or at any other time, with more than two courses and each mess of two sorts of victuals at the utmost, be it of flesh or fish, with the common sort of pottages without sauce or any other sort of victuals. And if any man choose to have sauce for his mess he may, provided it be not made at great cost; and if flesh or fish be to be mixed therein it shall be of two sorts only at the utmost, either flesh or fish, and shall stand instead of a mess except only on the principal feasts of the year, on which days every man may be served with three courses at the utmost, after the manner aforesaid."

But laws and proclamations were of no avail, though they continued to be issued and passed down to the reign of Queen Elizabeth; and in the reign of James I all sumptuary laws were repealed. Since then the people of England have been allowed to wear, to eat, and to drink what they pleased.

In our own country the experiment has been tried with as much thoroughness and with practically as little result as has attended the attempt by other nations. As early as the year 1639 we have the prototype of that curious law enacted a few years ago in the State of Iowa, which prohibits one person from inviting another to take a drink, or treating, as it is called.

In the records of the colony of Massachusetts for the year mentioned we find as follows:

"Forasmuch as it is evident unto this Court that the common custom of drinking one to another is a mere useless ceremony, and draweth on that abominable practice of drinking healths, and is also an occasion of much waste to the good creatures and of many other sins," such things are declared to be a reproach to a Christian commonwealth and are not to be tolerated. However, invectives of the council appear to have been of little effect, notwithstanding the severity of the punishments which were meted out to those who infringed the laws. Drunkenness, which is at most only a vice, was made a crime; and in 1636 one Peter

Bussaker was condemned for drunkenness to be whipped with twenty stripes well laid on. Robert Coles, for drunkenness committed at Roxbury, was condemned to be disfranchised, and to wear about his neck so that it would hang upon his outward garment a letter D, made of red cloth, and set upon white, to continue this for a year, and not to leave it off at any time in public, under penalty of forty shillings for the first offense and five pounds for the second. Severity of punishments appeared only to aggravate the evil against which they were directed, for in 1648 the Court was forced to declare that "it is found by experience that a great quantity of wine is spent and much thereof is abused to excess of drinking and unto drunkenness itself, notwithstanding all the wholesome laws provided and published for the preventing thereof." It therefore orders, with a blind perversity which is a remarkable instance of the fatuity which actuates people when they endeavor to accomplish the impossible, that those who are authorized to sell wine and beer shall not harbor a drunkard in their houses, but shall forthwith give him up to be dealt with by the proper officer, under penalty of five pounds for disobedience.

Tobacco, for some cause or other, was especially obnoxious to the early colonial authorities of Massachusetts. The trade in the weed was only allowed to the *old* planters, but the sale or use of it was absolutely forbidden unless upon urgent occasion for the benefit of health and taken *privately*. It was also ordered that victualers or keepers of an ordinary shall not suffer any tobacco to be taken into their houses, under penalty of five shillings for every offense, to be paid by the victualer, and twelvepence by the person who takes it. Further, it was ordered that no person should take tobacco publicly, under the penalty of two shillings sixpence, nor privately in his own house or in the house of another before strangers; and that two or more shall not take it together anywhere, under the aforesaid penalty for every offense.

It is true these laws against the use of tobacco are not so severe as some that have been enacted in other countries, but they were equally inefficacious. Thus, a Sultan of Turkey issued an edict to the effect that any one of his subjects detected in the act of smoking should for the first offense have his cheeks bored and transfixed by his pipe; for the second offense he was to have his nose cut off; and for the third he was to lose his head. Fines in the case of the New-Englanders, and mutilation and death in the case of the Turks, have not in the slightest degree prevented the use of tobacco; and that some recent laws to which I shall presently draw attention will prove equally futile there can be no doubt.

In all these instances of sumptuary laws the ground has been

taken that not only was the individual to be benefited, but that society as a whole was to be improved. Prohibitory laws relative to the manufacture and sale of alcoholic liquors which have been enacted in this country in our own times are based upon this assumption, but the arguments that have been used by those advocating such laws show that this is not the only motive by which they are governed. It has been and still is repeatedly asserted in the speeches and writings of these people that those who indulge in alcoholic liquors or in the use of tobacco spend money which could otherwise be more profitably used, and that indulgence in the habit of drinking or smoking directly conduces to idleness and luxurious habits. These assertions are probably true, and the laws against which the practices in question are directed are essentially sumptuary laws.

The laws which several States have enacted relative to the manufacture and sale of alcoholic liquors are true sumptuary laws, notwithstanding the fact that it is claimed by their adherents that they are measures which every independent State having a regard for the welfare of society is in duty bound to enforce. On that ground there are many other acknowledged evils against which the law-making power might very properly direct its energies, and which would interfere scarcely less with personal rights. One chief difficulty with such laws is that if thoroughly enforced, they do harm to those who never under any circumstances drink intoxicating liquors to excess, and yet who are benefited by their moderate use. As a matter of fact they never are enforced equally upon all classes of the community. In the most severe of all the States it is perfectly practicable for any person with pecuniary means to import as much alcoholic liquor for his own use and that of his family and friends as he chooses. The poor man, to whom a glass of beer or of wine taken decently and in order might not only do no harm, but might supply a positive want of his system, has to go without, or else resort to all kinds of deceit and subterfuge to get what he wants. States exceed their legitimate powers when they undertake to prevent a person doing that which is beneficial to him, and which does no harm to any one else. Moreover, as I have already said, such laws, being in this age of the world impossible of enforcement, tend to bring all law into contempt. It is not necessary for me to go into detail on this point; every one who hears me knows how the prohibitory liquor laws of the various States that have passed them are disregarded and ridiculed. Every now and then we hear of some instance where an offender is arrested and punished, but for every one brought before the courts a thousand go unnoticed. In the States of Maine, Vermont, and Rhode Island I know from my own personal experience that, notwithstanding the stringent liquor

laws that exist, it is just as easy for a person to get any kind of liquor he wants as it is in the city of New York.

Upon one occasion, at a prominent hotel in the State of Rhode Island, while at the dinner-table, I asked the waiter to bring me a bottle of champagne. He departed, but returned in a few minutes with the information that I could not have it without a medical prescription. I took his wine-card and writing the mystic symbol "℞," followed it with the words "vini campaniæ, ℥ xxxij—Sig.: To be taken p. r. n."—signing my name to it. In a few minutes he returned with the bottle, and I could have had as many more as I wanted on the same terms.

Several of the States, as we know, have recently receded from their advanced position on prohibition, and the State of Rhode Island has by its Legislature recently resubmitted the question to the people.

In the State of Iowa, not only is there a stringent prohibitory law, but it is made a penal offense for one person to ask another to take a drink. Of course, as I learn from reliable information, the law is almost a dead letter. It can be evaded in a hundred different ways. For instance, one man invites another into his house, takes him to the sideboard, and, perhaps in the presence of a dozen witnesses, pours out two glasses of whisky, drinks one himself, looks away for a moment, and his friend drinks the other. He has not disregarded the letter of the law. Are not such laws as this the height of human folly?

The State of Minnesota has quite recently struck out still further in the same direction, and has to a still greater extent interfered with the personal liberty of the individual. A law framed, as we are told, by Senator Schaeffer, has recently gone into effect in that State, and which is designed to punish drunkenness. It provides for a fine of from ten to forty dollars for the first offense, from forty to sixty dollars for the second offense, and ninety days in the workhouse for the third. When asked what effect the law would have on the Minneapolis municipal court, Judge Maloney said:

"It will not materially change the order of things with us. Our custom in treating drunkenness is much the same as provided in the new law. There is, however, one feature of the law that differs from the ordinance under which we formerly worked. According to the ordinance, the offense was not punishable unless committed in some public place, while the statute covers drunkenness in secret as well as in the public street. I am glad this bill passed the Legislature. It makes it a crime now in our State to drink to excess, and it is an expression of the public condemnation of drunkenness. I think it will result in doing a great deal of good. For the reasons I have cited, the new law has created

no unusual features in the pastime of drunkenness in this city as yet. Its eventual effect will, of course, depend greatly upon the leniency or strictness of the authorities."

Now, that drunkenness is both a vice and a sin is not to be questioned; but, if the law-making power sets out to punish vices and sins, it will have its hands full, and will attempt an impossible task. The world has tried this experiment in almost all ages, and uniformly without success. Not very many years ago the ordinances of the Church were in some countries enforced by law; and even now some nations, and, I am sorry to say, some of the States of this very Union of ours, inflict severe punishments upon profane swearers and blasphemers, thus again punishing sins and vices as though they were crimes. A sin or a vice does not necessarily inflict injury upon others, whereas a crime does. Drunkenness is not of itself, properly speaking, a crime; but if a person through his drunkenness creates disorder in the streets, or is offensive in any respect to those with whom he comes in contact, he ought to be punished to just that extent that his disorderly or offensive conduct requires. It is almost impossible for a person to be drunk in the public streets without being in some degree disorderly and offensive, and he is very properly arrested and fined or imprisoned.

But if any law can be more ridiculous, more outrageous in its influence upon the liberty of the citizen, it is this one which the State of Minnesota has recently enacted. A man, for instance, in the sanctity of his own house gets quietly drunk and goes to bed. He has injured no living being but himself, and he has a right to injure himself if he is such a fool. He has a legal right to cut off his hand, or to knock out his teeth, or to punch out his eye, even though by these acts he does inflict injury indirectly upon those who are dependent upon him. He has a natural right to take his own life, and though the State of New York (the only community, to my knowledge, that has such a law upon its statute-book) makes the attempt at self-destruction a crime, the law is so absurd that no one yet has been punished under it.

Moreover, the Minnesota law against drunkenness is almost impossible of enforcement, unless under such a system of espionage and domiciliary visiting as would render it intolerable to any people having a spark of manliness or independence in their character. Think of a police officer armed with a warrant entering a man's house, finding him in bed and in an apparent state of insensibility. He applies the only test known to the average policeman, and smells the breath of his potential victim. He detects the odor of alcohol, and straightway drags the supposed offender before a magistrate. The man may have had a headache, and have taken a glass of wine or of some other liquor; he is naturally

indignant at being treated in so outrageous a manner, and utters his protest in no measured language; his conduct only serves to convince his captors that the charge based upon the odor of alcohol is well founded, and he is mulcted in forty or sixty dollars, or sent to the workhouse for ninety days, as the case may be. No one is safe under such a law; it is often a very difficult matter to determine whether a person is drunk or sober, and frequently it is impossible even by the most minute examination. Again, some people become intoxicated from a single glass of champagne, while others will drink two or more bottles with impunity. It is manifestly unjust to allow an individual peculiarity like this to establish the guilt or innocence of an accused person.

As I have said, why stop at making drunkenness a crime when there are other vices far more immoral and more destructive to the character of the perpetrator? Why not enact a law against lying? There are laws against slander, which injures the one against whom it is directed, and they are well enough, for to injure another is a crime. But lying in the abstract remains unnoticed by the penal statutes, though a more degrading vice in the eyes of all civilized mankind than mere drunkenness.

On the first of June of the year 1889 a statute went into effect in the State of New York which prohibits, under severe penalties, the selling of cigarettes to minors under the age of sixteen; and the State of Michigan has recently not only enacted a similar law, but goes farther, and interdicts the manufacture of cigarettes within the limits of the State. Is it to be supposed for one moment that minors under the age of sixteen in either State smoke fewer cigarettes than they did before these laws were passed? How is the vender to know in many cases whether the applicant for cigarettes is over sixteen or not? And is there any difficulty for any minor to get a companion who is undoubtedly over sixteen, or some one else, to buy cigarettes for him? Legislatures that pass such laws, and governors that sign them, are apparently ignorant of the first principles of jurisprudence. I venture to say that even now, although not two weeks have elapsed since the act went into effect, it is practically a dead letter in the city of New York and throughout the State generally, and I am quite sure that not a single conviction will ever be obtained under its provisions. I am not certain that our society did its full duty in not protesting against the statute-books being encumbered with such rubbish. Cigarette-smoking by minors is an evil to be suppressed by proper instruction and by the intervention of parents and guardians. If these latter can not prevent it, it is quite certain that all the policemen in the State, backed by all the majesty of this particular law, will have their labor for their pains.

THE STRENGTH OF SPIDERS AND SPIDER-WEBS.*

By HENRY C. McCOOK, D. D.

THE frailty of a spider's web has passed into a proverb. Yet, comparatively, the silken line of an orb-weaver is very strong. According to Schaffenberger, it requires ninety spinning threads of an *Epeïra* to yield one thread of the thickness of a caterpillar's thread; and, according to Leeuwenhoek, it requires eighteen thousand spider lines to make the thickness of a hair of the beard. These comparisons are suggestive, although in a measure deceptive, since there are vast differences in the size of the threads woven by Epeïroids. It is probable that the extraordinary strength of the thread is due to the superposition of a large number of extremely minute threads. However, after the thread is woven, Meckel could not recognize it as consisting of more than eight to ten strands. A geometric snare, whether vertical or horizontal, must be strong enough to sustain the weight of a spider of considerable size, such as *Argiope cophinaria* or *Epeïra insularis*, particularly when the female is heavy with eggs.

Blackwell thus determined by experiment the strength of a line by which a female *Epeïra diadémata*, weighing ten grains, had sustained itself from a twig: He attached to the extremity of the line a small piece of muslin with the corners nearly drawn together, so as to form a minute sack, into which he carefully introduced sixty-one grains' weight in succession, being more than six times the weight of the spider. On the addition of half a grain more the line broke.

Not only must an orb sustain the weight and movements of its maker, but it must also have sufficient strength to hold the various insects which strike upon it. Bees and wasps are sometimes able to break through the spiral meshes of a large snare, but generally the threads are strong enough to hold them, in spite of their struggles, until the proprietor can enswathe them. Moreover, the orb-web must be able to sustain the weight of evening dews. One who has seen such snares in the early morning, when every viscid bead appears to have attracted to itself an incasing armor of silvery dew, and has noticed how the spiral strings are bagged down under the weight of the same (Fig. 1), must have inferred that the snare was able to support a comparatively heavy burden. The same is true concerning summer showers, which must fall very heavily, and be driven before a pretty strong wind, in order to batter down a well-constructed orb-web.

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* Reprinted from Vol. I of American Spiders and their Spinning-Work, by the kind permission of the author, to whom we are also indebted for the accompanying illustrations.

An illustration of the remarkable strength and elasticity of the foundation lines of orb-webs appears in a biographical notice of the distinguished astronomer, the late General Ormsby M. Mitchell, printed with an edition of his lectures. Prof. Mitchell directed his great ingenuity to the problem of causing a clock to record its beats telegraphically, and at the same time perfectly perform the work of a time-keeper. The required makes and breaks in the battery were effected by means of a cross of delicate wire and a mercury-cup. Many obstacles having been overcome, there arose the great difficulty of procuring a fiber sufficiently minute and elastic to constitute the physical union between the top stem of the cross and the clock pendulum. Various materials were tried, among others a delicate human hair, the very finest that could be obtained, but this was too coarse and stiff. Its want of pliancy and elasticity gave to the minute "wire cross" an irregular motion, and caused it to rebound from the globule of mercury into which it should have plunged. "After many fruitless attempts," says Prof. Mitchell, "an appeal was made to an artisan of wonderful dexterity—the assistance of the spider was invoked; his web, perfectly elastic and perfectly pliable, was furnished, and this material connection between the wire cross and the clock pendulum proved to be exactly the thing required. In proof of this remark I need only state the fact that one single spider's web has fulfilled the delicate duty of moving the wire cross, lifting it, and again permitting it to dip into the mercury every second of time

FIG. 1.—SECTOR OF A DEW-LADEN ORB-WEB. (Magnified.)

for a period of more than three years! How much longer it might have faithfully performed the same service I know not, as it then became necessary to break this admirable bond, to make some changes in the clock. Here it will be seen that the same web was expanded and contracted each second during the whole period, and yet never, so far as could be observed, lost any portion of its elasticity."

At various times there have been placed on record accounts of the capture by spiders of small vertebrate animals, as snakes, mice, and birds. Popular stories to the same effect have from time to time been sent the rounds of the daily press, and found utterance and often illustration, the latter sometimes of a most original and remarkable character, in popular magazine literature. The great seeming disparity, in such cases, between the size and vigor of captive and prisoner; the confusion of the various narratives in details as to the species and behavior of the spider, and the characteristics of her snare; the radical departure from known food habit of species that are insectivorous; together with the fact that the accounts all have come from lay observers, have been more or less lacking in scientific accuracy and minuteness of detail, and wholly without scientific verification—these considerations have caused such records and reports to be discredited by arachnologists and naturalists generally. But there are a few cases, confirmed by circumstantial evidence, and reported by observers of good reputation and careful habit, which deserve notice.

The physical powers of the *Lycosidæ*, the popular running, ground, or wolf spiders, are well illustrated by an instance recorded in the proceedings of the Academy of Natural Sciences of Philadelphia. The result as reported was achieved by pure strength and activity, without any of the mechanical advantages of a snare. Mr. Spring, while walking with a friend in a swampy wood, which was pierced by a dike three feet wide, was attracted by the extraordinary movements of a large black spider in the middle of a ditch. Closer examination showed that the creature had caught a fish! She had fastened upon it with a deadly grip just on the forward side of the dorsal fin, and the poor fish was swimming round and round slowly, or twisting its body as if in pain (Fig. 2). The head of its black enemy was sometimes almost pulled under water, but the strength of the fish would not permit an entire submersion. It moved its fins as if exhausted, and often rested. Finally it swam under a floating leaf near the shore and made a vain effort to dislodge the spider by scraping against the under side of the leaf.

The two had now closely approached the bank. Suddenly the long black legs of the spider emerged from the water, and the hinder ones reached out and fastened upon the irregularities of

the sides of the ditch. The spider commenced tugging at his prize in order to land it. The observer ran to the nearest house for a wide-mouthed bottle, leaving his friend to watch the struggle. During an interval of six or eight minutes' absence the spider had drawn the fish entirely out of the water; then both creatures had fallen in again, the bank being nearly perpendicular. There followed a great struggle, and on Mr. Spring's return the fish was already hoisted head first more than half its length out upon the land. It was very much exhausted, hardly making any movement, and was being slowly and steadily drawn up by the spider, who had evidently gained the victory. She had not once quit

FIG. 2.—A FISH CAPTURED BY A DOLOMEDE SPIDER.

her hold during the period of a quarter to half an hour of observation. Her head was directed toward the fish's tail; she stepped backward up an elevation of forty-five degrees, dragging her captive with her.

The observers were unfortunately unable to await the issue of the matter, and therefore caught the combatants in the bottle, partly filled with water. The fish swam languidly at the bottom of the vessel, and the spider stood sentinel on the surface, turning when the fish turned and watching every motion. The bottle was set aside and visited after an interval of three hours. The spider was then found dead at the bottom of the jar, but the fish was alive and lived twenty-four hours afterward. The spider was three fourths of an inch long and weighed fourteen grains; the fish was three and one fourth inches long and weighed sixty-six grains. The spider was probably bruised by the catching.

One of the most remarkable records of the physical and mechanical powers of spiders is made in Silliman's Journal. The account is authenticated by the names and statements of a number of gentlemen resident in the vicinity of the occurrence, Batavia, N. Y. One evening Hon. David E. Evans found in his wine-cellar a live striped snake, nine inches long, suspended by the tail in a spider's web between two shelves. The snake hung so that its head could not reach the shelf below it by about an inch. The shelves were about two feet apart, and the lower one was just below the bottom of a cellar window, through which the snake probably passed into it. From the upper shelf there hung a web in the shape of an inverted cone, eight or ten inches in diameter at the top, and concentrated to a focus about six or eight inches from the under side of this shelf. From this focus there was a strong cord made of the multiplied threads of the spider's web, apparently as large as sewing-silk, and by this cord the snake was suspended. A rude sketch of the serpent suspended in the web was made by an eye-witness, and is exactly reproduced at Fig. 3. A close examination showed that the snake's mouth was entirely closed by a number of threads wound around it. Its tail was tied in a knot so as to leave a small loop or ring, through which the cord was fastened, as seen in the figure.

FIG. 3.—A SNAKE ENTANGLED IN A SPIDER'S WEB.

Accepting the account as true, or at least probable, I would make the following inferences: First, the description of the web, although sufficiently indefinite, leaves little doubt that the snake was originally taken in a snare of a species of tube-weaver, and most probably by the medicinal spider, *Tegenaria medicinalis* (Hentz). The broad-sheeted web of this spider is frequently found in cellars, which are favorite haunts. It builds near windows, in the angles and along the sides of walls, having its tubular den in a crack or opening laid along an angle (Fig. 4). The sheet is usually drawn upward until its exterior margin is higher than the plane of the entrance of the tube. There is thus formed a sort of pouch within which insects often fall, and so are readily captured by the spider, who mounts guard at the door of her den. Over the door the tube frequently rises into a sort of tower.

I had often wished for an opportunity to follow up critically one of the recurring reports of the physical powers of spiders.

This wish was gratified in the summer of 1882. An article drifted through American newspapers which detailed the ensnaring of a living mouse by a Kentucky spider. I was fortunately able to trace the story to its origin in the Lebanon (Ky.) Standard and Times. Correspondence with its intelligent editor, Mr. J. W. Hop-

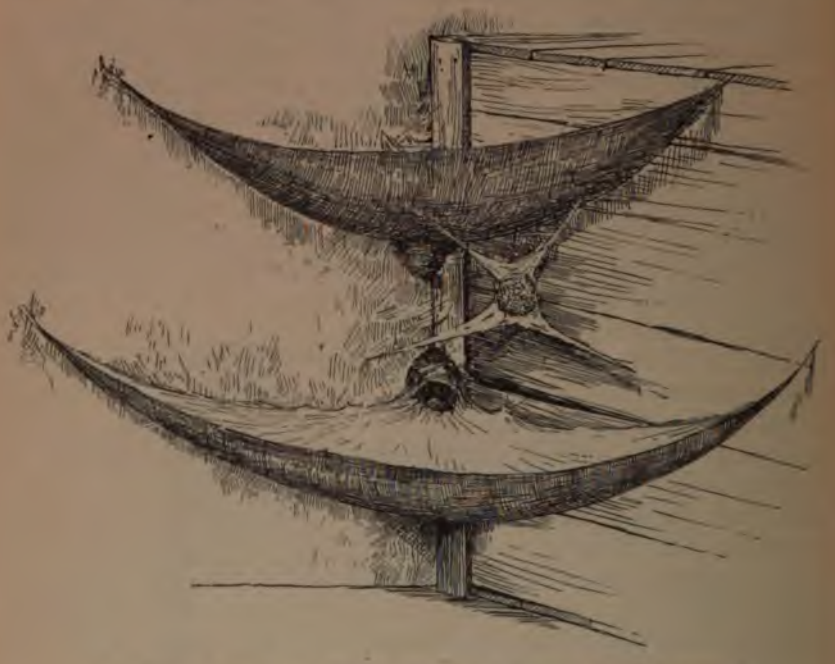

FIG. 4.—THE POUCH, WEB, TOWER, AND COCOON OF THE MEDICINAL SPIDER.

per, brought me entire confirmation of the report from a number of trustworthy sources. I think the incident of sufficient importance to justify a somewhat detailed presentation. The original account, as published by Mr. Hopper, is as follows:

"A very curious and interesting spectacle was to be seen Monday afternoon in the office of Mr. P. C. Cleaver's livery-stable in this city. Against the wall of the room stands a tolerably tall desk, and under this a small spider, not larger than a common pea, had constructed an extensive web reaching to the floor (Fig. 5). About half past eleven o'clock Monday forenoon, it was observed that the spider had ensnared a young mouse by passing filaments of her web around its tail. When first seen, the mouse had its fore-feet on the floor, and could barely touch the floor with its hind-feet. The spider was full of business, running up and down the line and occasionally biting the mouse's tail, making it struggle desperately. Its efforts to escape were all unavailing, as the slender filaments about its tail were too strong

for it to break. In a short time it was seen that the spider was slowly hoisting its victim into the air. By two o'clock in the afternoon the mouse could barely touch the floor with its fore-feet; by dark the point of its nose was an inch above the floor. At nine o'clock at night the mouse was still alive, but made no sign except when the spider descended and bit its tail. At this time it was an inch and a half from the floor. Yesterday morning the mouse was dead, and hung three inches from the floor. The news of the novel sight soon became circulated, and hundreds of people visited the stable to witness it. The mouse was a small one, measuring about an inch and a half from the point of its nose to the root of the tail."

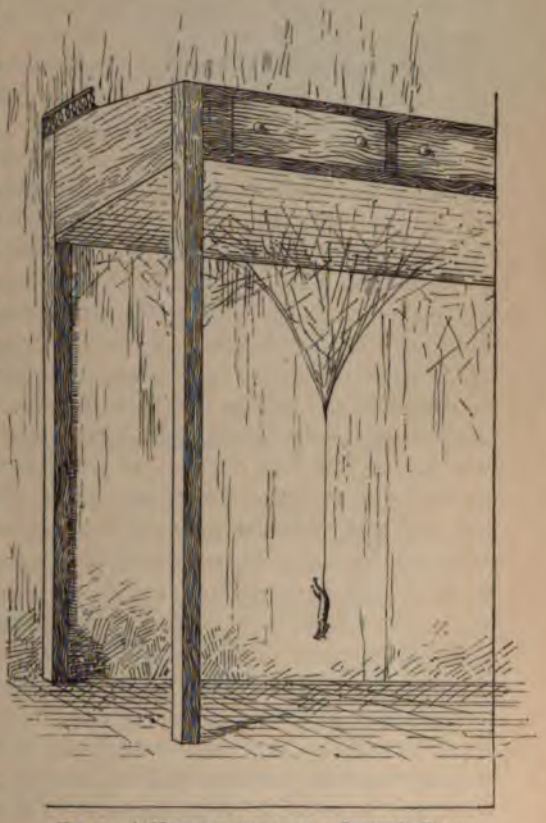

FIG. 5.—A MOUSE HANGING IN A SPIDER'S SNARE.

The space given the above facts may seem to some to be in undue proportion to their importance. But, apart from the value of positively determining any point in natural history, the discussion has this conclusion: The capture of small vertebrate animals by both sedentary and wandering spiders is possible; the one by the mechanical strength of their snares, the other by their physical strength. There is thus laid the foundation, at least, for the presumption that such animals may be or become natural food for the larger species of araneads. This is certainly a most important fact in the life-history of spiders, and would greatly enlarge the range of their habits.

MR. F. J. MOSS, of the New Zealand Legislature, and an extensive traveler in Polynesia, suggests that the deterioration of the natives of those regions may be partly due to faulty instruction. It is neither desirable nor expedient to thwart Nature too much. What is most needed, this author thinks, is to allow the islanders in their work and their amusements free scope for the imaginative powers with which they are endowed, and the exercise of which is too often foolishly discouraged.

SECONDARY SCHOOL PROGRAMMES—FRENCH AND AMERICAN.

By GEORGE W. BEAMAN.

THE general subject of American secondary school programmes has been of late years a most prolific one. What with the relative or particular importance of the mother-tongue, classical studies, history, modern languages, and, more recently, manual training, the educational essayist has been rather embarrassed by the multitude of the topics presented him. As the result of much discussion, contention, and wordy warfare, we have, however, to-day, certain secondary school programmes, generally speaking quite similar in their character, marking in a more or less defined manner the routes along which our boys are traveling on their respective journeys to college, to scientific school, or to practical business life. While there is to be noted a decided advance and improvement in pedagogical methods in our secondary schools within the last few decades, it yet remains true that no intelligent reader of the programmes, as exhibited in the catalogues of our leading endowed fitting schools, and public grammar and high schools, can fail to be struck by a certain lack of co-ordination, system, and, in most instances, by an apparent want of a genuine appreciation of the real demands that the present age makes upon modern secondary schools. Once outside the old fixed limits of the classics, there is to be observed much disagreement among the schools themselves, both as to the proper subjects to be included in the programme and the relative time to be devoted to the studies that are placed in the school curriculum. When comparison of these programmes with those of other countries is made, we have at once afforded us a most striking exemplification of how far we still are in this country from any well-defined consensus as to what the modern secondary school programme really should be. In view of the revolutionary period through which the schools have been passing during the past thirty years, this is perhaps hardly to be wondered at. The broadening of the college requirements for entrance, largely brought about by the demands of a public sentiment, no longer fully satisfied with purely mediæval curricula, has in itself served to call for many modifications of the secondary schools' programme. With Harvard and Johns Hopkins opening their doors to students unequipped with the traditional Greek, there has of course arisen a demand for preparation in other prerequisites which have necessarily been substituted for Greek. In response to the general outcry for them, the courses in modern languages, in the mother-tongue, history, and

particularly in science studies, have had to be greatly extended or recast. The many admirable scientific schools and colleges throughout the country have made demands for special preparation that have had to be met. Furthermore, it has come to pass that the college prerequisites in the old classical studies even have been very considerably increased. Altogether it may be stated that the demands made upon the preparatory schools to-day are probably at least twenty-five or thirty per cent in excess of the demands of twenty-five or thirty years ago. Coincident with this multiplication and extension of preparatory studies, there has arisen in our country a sentiment which to no inconsiderable extent has reduced the hours devoted to study. A few decades since a boy fitting for college with its limited requirements in Latin, Greek, and mathematics, spent six hours per diem in school, and, as a matter of course, expected to give two, three, or possibly more hours to study at home. Now, he spends four or five hours in the school-room; and the sight of a text-book under his arm as he idly saunters homeward excites comment in the community as to the severe mental strain to which school-children are nowadays subjected by rigorous masters.

The result of all this is a state of affairs to which President Eliot, of Harvard University, has recently invoked the serious attention of the American public.* He states that the average age of admission to Harvard University has been gradually rising for many years, and has now reached the extravagant age of eighteen years and ten months. He also notes that in view of the increased time required for the completion of his professional education, after leaving college, it follows that a man, thoroughly preparing himself for life, finds himself unprepared for self-support much before he is twenty-seven years old. This result is by no means peculiar to Harvard or to Harvard graduates, but holds true as to all colleges in the United States. Its remedy, in the opinion of President Eliot, is in both shortening and enriching our secondary school courses of study. As illustrating what other countries have succeeded in doing in this direction, he cites the school courses of France. The hours of recitation of these courses, less elaborate and difficult than those of Germany, are, he claims, so far as hours of recitation are concerned, substantially the same as those of this country; yet, under them, the French boy is better prepared for matriculation at seventeen years of age than ours are at nineteen. He therefore calls for a serious examination of the programmes of *l'enseignement secondaire classique* of France in comparison with the programmes of American preparatory

* A paper read before the Department of Superintendence of the National Educational Association at Washington, February 16, 1888, published in the Atlantic Monthly, August, 1888. Remarks before the Commercial Club, Providence, R. I., March, 1889.

schools, as likely to yield results which can not but be conducive to educational progress in this country.

As might be expected from the eminence of its author, the paper of President Eliot has excited much interest in regard to the French secondary school programmes. Much comment has resulted both as to the facts and the conclusions arrived at. The facts represented in the address as to the age of matriculates in American colleges are only too patent. The defects of the programmes of the preparatory schools of this country are unfortunately equally patent. The great need of some readjustment of existing methods of our fitting schools and schools of grammar and even primary grades, for the benefit of boys preparing for modern collegiate, scientific, and university training, is so imperative that no friend of educational advance in this country can fail to welcome this valuable contribution to the literature of the subject given by the President of Harvard University. But, notwithstanding his admirable paper, and the comment which has followed, so far as one can judge from the literature of the controversy, no one has apparently made haste to follow President Eliot's advice and make any serious comparative examination of the French and American school programmes. On the contrary, there are indications that, with true American inconsequence, many persons are already either clamoring for the adoption of the French curricula forthwith, as a panacea for all our secondary school deficiencies, or, with great lack of knowledge and accurate information, are condemning them outright as a foreign growth quite unsuited to American soil. This is to be regretted; for assuredly the comparative study of the programmes of the two countries would give American school boards and American parents much information that should be known and accurately known. This examination is additionally desirable from the fact that, in his felicitous presentation of some characteristics of the lycée curriculum, Dr. Eliot seems to have omitted to note some of the more important features of the programmes that give them their strength, and has quite failed to point out how it happens that the French boy is really enabled to pass his examinations for the *baccalauréat ès lettres* at the early age of seventeen years. It may also be said that the examination is likewise desirable for the reason that President Eliot has inadvertently made some statements as to the French courses of study that the official programmes hardly seem to warrant.

In the present paper the attempt will be made to present, in a somewhat more precise manner than has been undertaken by President Eliot, certain details of the curricula of not only the classical lycées, but also of the secondary special schools of France. In connection with this, the attempt will also be made to

exhibit, with equal precision, some facts as to comparative courses in vogue in typical preparatory schools of the United States. Following the suggestion of Dr. Eliot, particular reference will be made to the Public Grammar and Public Latin School of the city of Boston. To obtain the requisite data the writer has first tabulated the hours of recitation per week entering into the *enseignement secondaire classique* and the *enseignement secondaire spécial* of France. These tables have then been brought into comparison with similar tables, prepared on precisely the same plan, of the courses of study in both the classical and scientific departments of certain typical fitting schools in the United States. The hours of recitation having been made the unit of the tabulation, the tables thus exhibit the total number of recitations in every subject taught, each year, and for the entire course of every school subjected to this examination. From the resultant figures the percentage of each study to the whole course has been also derived. The data as to the French courses were collated from the latest official programmes of the schools, as prescribed by the order of January 22, 1885, for the classical lycées,* and by the order of August 10, 1886, for the secondary special schools.† The data as to American schools were derived from information supplied by the head masters of the schools in question. The result of this tabulation has been to exhibit in full relief the curricula of both countries, and to bring into graphic view some very striking points of difference in the courses of study as carried out in the French and American schools, as well as to expose many singular differences of practice obtaining in our own schools. The large space that these tables would occupy precludes their publication in connection with this paper, but the methods of compilation are here mentioned, in order that such statements as may be made by the writer as to the details of the courses of instruction in both countries may be depended on as being as absolutely correct as a careful and conscientious tabulation can make them.

The programmes thus compared, at once exhibit two most important facts to which President Eliot has made no reference whatsoever, viz.: that if a boy in France is prepared for matriculation at seventeen years of age, instead of nineteen, as with us, it is due (1) to the fact that, between the ages of eight and seventeen, the French boy devotes more time to study than the American boy; and (2) to the further fact that, with his increased amount of reading, the French lad has had eliminated from his preparatory course the serious study of subjects considered by the

* Plan d'Études des Lycées—Programmes de l'Enseignement classique. Paris: Maison Delalain Frères.

† Plan d'Études et Programmes de l'Enseignement secondaire spécial dans les Lycées et Collèges prescrit par Arrêté du 10 Aout, 1886. Paris: Maison Delalain Frères.

French school authorities non-essential to that particular course, but which with us are still firmly intrenched in every preparatory school programme; in brief, that the results obtained under the French programmes, in both the classical and scientific preparatory schools, are due to honest hard work, persistently continued for a term of years on a well-defined plan, which is characterized by a complete disjunction of the courses that lead to college, from those that are intended for youth for whose anticipated career in life a knowledge of the classical languages is not deemed essential.

A comparative examination of the programmes of the Boston Latin School with the French lycée course brings out this excess of hours in the French school very prominently. The French boy, in his ten years' sojourn in the lycée, spends 8,560 hours in the recitation-room, while in the corresponding course in Boston* the recitation hours are 7,790 only. With a ten-per-cent excess in recitation hours, and a corresponding increase of study, it is evident that the two courses can not be considered "as substantially of the same strength." However much we might "enrich" our curricula by imitating French methods, it seems quite clear that we certainly could not, by this process, hope to "shorten" them any.

Turning to the relative assignment of time to the subjects taught in common by the two schools, there is to be noted also one other point where the statistics and Dr. Eliot are at variance. One searches in vain for that "preponderance" of time given to the French language in the lycées as compared with the instruction in the English language in the Boston Latin School. In fact, the "preponderance" is, on the contrary, altogether on the side of the Boston schools, where over twenty-eight per cent of the whole course is devoted to the mother-tongue, to only 20·8 per cent in the lycées. This is an interesting fact, which will doubtless be surprising to most readers. It is a prevalent opinion in the United States that in our schools too little time is devoted to the study of our own language. And lest it may be urged that this "preponderance" is offset by the nine hours' course per week in philosophy, given in the last year, where, President Eliot states, "French resumes almost exclusive possession of the programme," it may be said that, according to the official programme, this claim can not be legitimately made. The course of philosophy in question em-

* The programme of the Boston Latin School, embracing six years of study, and that of the French lycées ten years, there have been prefixed to the tables of the Latin School—for purposes of comparison—the recitation hours of four years of the grammar-school courses preliminary to it. All references to the Latin School courses in this paper will, therefore, be understood as embracing the result of tabulation of ten years' school work—not that of the six years' course of the Latin School proper.

braces the elements of psychology, logic, morals, and metaphysics, with a study of the principal schools of philosophy and the various philosophical authors. In connection with the last-mentioned branch of the course, as is natural, considerable prominence is given to the French philosophical writers, and one hour per week of the nine is expressly devoted to the Latin and Greek authors. This course of philosophy, admirable as it is, and interesting as (perhaps) it may be to the average youngster of seventeen years, can in no sense be properly classed as an adjunct to the mother-tongue instruction, except in so far as history, geography, or any other branch of study, carried on in the vernacular, can be so considered. In the programme it is very properly classified by itself.

Referring to the courses in modern languages, there is certainly here no question as to where the preponderance lies. In the French lycée the living languages are made prominent from the preparatory year, and the strength of the course developed in the first three years. The total is 1,000 hours, or 11·7 per cent of the whole hours, compared with 380 hours, or 4·9 per cent only in the Boston Latin School. Latin and Greek, which naturally form the *pièces de résistance* of the French classical course, are, as one might expect, much more prominent than with us. The Latin is begun in *cinquième*, the pupil eleven years of age, with ten hours of recitation per week, and is continued with reduced hours for six years, giving a total of 1,500 hours, against 1,293 hours at the Boston Latin School. In the last year (*classe de philosophie*) the technical study of Latin is omitted, but, as above stated, one hour per week of the nine allotted to philosophy is devoted to Greek and Latin authors, the original texts being freely employed. Greek is begun in the second term of the fourth year of the course, the pupil twelve years of age, with two hours per week for the rest of the year, and is continued through the *classe de rhétorique*. Taken together, the Greek and Latin recitations of the French course occupy 2,340 hours, contrasted with 1,805 hours in the Boston Latin School.

The importance attached to drawing in the French scheme of instruction is shown by the considerable time devoted to it. This is in most striking contrast to the almost general neglect of this important branch of education, not only at the Latin School of Boston, but at nearly all classical fitting schools in the United States. In the French lycée 7·9 per cent of the whole course is devoted to drawing; in the Boston Latin School the percentage is 2·9.*

Among the various illustrations of the difference of the two

* In the Latin School proper no instruction in drawing is given. The percentage referred to is derived from the preceding grammar-school courses.

programmes, none is more interesting than that of the relative number of hours devoted to mathematics in the French and American courses. The figures are as follows: French lycée, 740 hours; Boston Latin School, 1,387 hours. The French boy arrives at the end of his classical preparatory course of study, having been subjected on an average to less than two hours of recitation per week in mathematical subjects. The average American pedagogue would certainly rise with protests deep, and disgust profound, if ever it were proposed to him to fit a boy for college with an allowance of only 8·7 per cent of the whole school course for his arithmetic, algebra, and geometry.* Yet this is precisely what the French do—in their classical course. In the Boston representative course the percentage is 17·8 per cent.

As the treatment of mathematics in the French classical course, with the limited time allotted to this study, is of general interest, a *résumé* of it is given here. In the preparatory class of the lycée, as well as in the *classe de huitième* following, the allotted time is devoted to simple arithmetical work in whole numbers, mental work, and to the solving of easy problems. In *septième* (third year of the course) are added decimal numbers and the metric system, with drawing of geometrical figures. In the next year there is a review of work on whole numbers, a continuation of mental exercises and problems, and decimals; work on fractions is entered upon, and elementary geometry is begun. In the succeeding year arithmetic is continued, with the study of the rule of three, interest, discount, with simple problems in alligation, a detailed review of the metric system, and with further very elementary geometrical exercises. In *quatrième*, theoretical geometry is begun, with one recitation per week. In *troisième*, the two hours per week are devoted to a review of arithmetical subjects,

* The percentage of hours devoted to recitations in mathematics, in such typical fitting schools of the United States as have supplied data to the writer, is as follows: Boston Latin School (with four years' grammar-school course added), 17·8 per cent. Boston English High School (with two years' grammar-school course added), 16·6 per cent. Phillips Academy, Exeter, N. H., classical course, 26·5 per cent; scientific course, 26·9 per cent. Williston Seminary, Easthampton, Mass., classical course, 26·7 per cent; scientific course, 25·7 per cent. Phillips Academy, Andover, Mass., classical course, 25·7 per cent; scientific course, 28·8 per cent. St. Paul's School, Concord, N. H., classical course, 24·9 per cent; scientific course, 27·8 per cent. Lawrenceville School, Lawrenceville, N. J., classical course, 17 per cent; scientific course, 22·7 per cent. St. Mark's School, Southborough, Mass., exclusively classical, 21·6 per cent. Doubtless these percentages may, in some of the schools cited, be increased or decreased in the case of certain pupils; but they represent the mathematical courses as prescribed for the major portion of them. How strikingly the figures illustrate the different methods of treatment of the mathematical question, in the United States and France, will be understood when it is further stated that the percentage allowed to mathematics in the French lycée course is only 8·7 per cent, and in the secondary special course, where mathematical studies are considered by the French to be especially prominent, only 17 per cent.

elementary algebra is begun, and geometry is continued. In *classe de rhétorique* (ninth year of the course), two hours a week are devoted to recitations in solid geometry and cosmography; and in the last year (*classe de philosophie*), four hours per week, are devoted to a complete review of the work of the previous years in arithmetic, algebra, and geometry.

It must be admitted that in this country the mathematical instruction, sketched above, would be thought to afford a somewhat meager outfit for a young man intending to present himself for examination at any of our American colleges, with their present mathematical prerequisites. It is also obvious that the French, who, according to President Eliot, "are quite as skillful with numbers as the Americans," do not gain a skill in "ciphering" in the classical lycée course. This proficiency is obtained elsewhere, as will be further shown. The French are, indeed, not only skillful with numbers, but are as a nation eminent for their mathematical ability; and their management of the much-vexed problem of the relative time to be devoted to elementary mathematical branches in the classical fitting schools commends itself to the serious consideration of American educators. A comparative exhibit of the classical lycée and Boston School courses clearly shows that it is to the excess of hours of recitation as a whole, and in no small degree to the holding of mathematical studies in abeyance, that the French are enabled to accomplish what they do in the way of bringing their boys to college at an early age. Give to the Boston course, for instance, ten-per-cent increase of recitations, plus the difference existing at present between the respective hours given to mathematical studies in the lycée and Latin School courses, and we have 1,426 hours. This is more time than is at present devoted to Latin, in the Boston Latin School, during its entire six years' course. It still more closely represents the difference in the respective hours given in the two countries to modern languages and drawing, with the hours of the entire course in philosophy added. It clearly follows—reversing the point of view—that Harvard has but to slightly reduce its requirements in mathematics to the French lycée standard, to enable it to obtain from its matriculates —those coming at least from the Boston Latin School—not only the attainments in philosophy considered so desirable by its president, but also considerable proficiency in such other branches of the French programme as its honorable faculty may "elect" to receive.

With the present public sentiment, and especially in view of the present requirements in mathematics on the part of American colleges, it is not probable that we can look for a reduction in mathematical studies in our classical preparatory courses to the point exhibited by the programmes as existing in France. But

that the protest against the excessive and unnecessary time given to mathematical instruction in all our schools which has begun, will continue, none can doubt. As is well known, no primary or secondary school programme of this country can be scratched without revealing an omnipresent Tartar known as arithmetic. This mathematical Cossack is ever found firmly settled in his saddle, and foraging for subsistence hither and yon, upon friend and foe alike. The result is, that in the classical preparatory school the boy is hampered and handicapped by serious mathematical studies which absorb time that he could more profitably devote to his mother-tongue, to modern languages, and to science studies. On the other hand, in the scientific or English courses, the pupil fitting for the scientific school, or for business, is forced to take unwelcome draughts of Latin. These last are somewhat diluted, it is true, and are given perhaps on the general principle entering into the administration of certain family medicines, viz., that if not of any direct service to the patient, they can do him no possible harm. But in point of fact, while as a rule the Latin given in these brief courses can be of little or no value to a pupil fitting for the scientific school, time is taken from subjects having a direct personal bearing on his future career. It is interesting to note how, in France, this feature of instruction is managed.

A French boy having passed through the grades of the lycée classique, as exhibited in the preceding table, and intending to devote himself to a literary profession, proceeds without further ado to his examination for the *baccalauréat ès lettres* wherein mathematics plays but a subordinate part, as is indicated by the small percentage of time given it in the lycée course. But, for the benefit of graduates designed for the national schools, or for those who prefer to present themselves for examination for the *baccalauréat ès science* instead of *ès lettres* post-graduate lycée mathematical courses are instituted. The *classe de mathématiques élémentaires*, for instance, has for its object the study of matters comprised in the programmes of the *baccalauréat ès sciences*, as well as those of the military (Saint-Cyr), the naval, and forestry schools and the central school. The curriculum of this class devotes seven and a half hours per week to mathematics, four and a half hours to science studies, two each to the mother-tongue, Latin and modern languages, three hours to history and geography, one hour to philosophy, and four hours to drawing. This course is of but one year. It is usually taken by pupils from the *classe de rhétorique*, but may be taken by pupils from the *classe de philosophie* who wish to review and increase their mathematical attainments. A much stiffer and more comprehensive drill in mathematics is afforded by the *classe de mathématiques spéciales*. This course is also of but one year. The instruction

given in this class has for its object the preparation of pupils who have completed the lycée course, and who purpose entering the polytechnic, the superior, or the central schools. None are admitted to this course who have not previously manifested an aptitude for it. The hours of recitation per week are, mathematics eleven hours, descriptive geometry three hours, physics and chemistry five hours, natural history three hours, French language two hours, modern languages two hours, history and geography three hours, and drawing two hours; total, thirty-one hours.

The instruction to-day given in France under the name of *l'enseignement secondaire spécial* has found a secure footing only after many years of violent discussion and constant opposition. Its career, however, has been steadily advancing and gaining in public consideration ever since its organization in 1865. Its programme was extended and revised in 1881, and in 1886 it was organized on its present basis. The courses of study have been framed with especial reference to the requirements of a large class of pupils of good social position, who have neither the desire, the tastes, nor perhaps the leisure for long years' study of dead languages. It is a response to the needs of a large class for a preparation for actual life in various careers, which the classical courses are incapable of giving. The school is in a sense the Realschule of the French, differing from its German congener, however, by the entire elimination of Latin from its programme. The course comprises six years of study, crowned, at its successful termination, by the diploma of *bachelier de l'enseignement secondaire spécial*, the possession of which entitles the holder to admission to the examinations for the *baccalauréat ès sciences*, for the military school of Saint-Cyr, and, with the exception of the Polytechnic School, which still holds to its classical requirements, to other national schools with requirements of a general similar character.

However interesting, as an illustration of French school methods, the curriculum of the secondary special schools may be, the severity of the course, as a whole, renders it unlikely that it will ever be very closely imitated in this country. The recitations here range from twenty-five to twenty-nine hours per week, giving, for the whole course, 6,360 hours, against 4,360½ hours in the American representative of the same type of school.* The official

* As the secondary special schools of France occupy about the same place in the French system as the upper classes of grammar schools and the English high schools occupy in ours, the French programmes of these schools have been brought by the writer into comparison with a typical American school—the courses of the two upper classes of the grammar schools and those of the English High School of Boston being employed as a fair American representative.

programme shows that the instruction of these 6,360 recitation hours are distributed as follows: Mother-tongue, 1,000; modern languages, 1,160; history, 360; geography, 280; mathematics, 1,080; science studies, 960; drawing, 960; penmanship, 160; book-keeping, 80; morals, 40; legislation, 80; political economy, 40; philosophy, 160. The ages of the pupils average eleven years in the first and sixteen in the last class. The recitation hours of a pupil passing through the last two grades of the grammar school, and the four years' course of the English High School in Boston are, barring certain changes on account of options, as follow: Mother-tongue, 1,111½; modern languages, 494; history, 570; geography, 152; mathematics, 722; drawing, 760; book-keeping, 95.

Here, again, as in the case of the French classical lycée course, the instruction in the mother-tongue is found to be less than in the American representative school. The hours devoted to modern languages (1,160) are, in fact, somewhat in excess of those given to French (1,000), and, it may be added, are in most marked contrast to the time allotted to the same study in the Boston High-School programme (494), even after the latter has received a credit under this head for a certain number of hours that in point of fact are used by many pupils for Latin.

Mathematics, which, as has been seen, plays but a subsidiary *rôle* in the classical lycée course, in the secondary special course assumes more prominence comparatively, the average being 4½ hours against 3⅓ hours' recitation per week in the typical American programme. Yet even here it is not up to what may be termed the United States standard. A tabulated exhibit of the hours of the classical courses of the two countries shows that an average of only one hour and fifty minutes per week is given to mathematics in the classical lycée course, compared with an average of three hours and forty minutes in the Boston classical school course. A comparison of that course with the French secondary special programme develops also the fact that a typical American classical school not only devotes more hours to mathematics than the French consider essential for a preparatory scientific course, but also exhibits the further surprising fact that the Boston English High-School course, with two years of grammar-grade school prefixed to it, actually gives less time to mathematics than is devoted to that study in the six years' course proper of the Latin School. And this is not by any means peculiar to the Boston school courses. The programmes of other schools exhibit a treatment of the mathematical subjects quite similar. At Phillips Exeter precisely the same number of hours is given to mathematics in the classical and scientific courses. At Williston, even after adding the course in surveying to the mathematics, the per-

centage of the latter to the whole course is less than on the classical side.

From the data here given it seems clear that if we are to hope to put our schools on anything like an equality with those of France, to say nothing of those of other civilized countries of the world, certain modifications of our school programmes have certainly to be made. First and foremost among those changes there would seem to be indicated a need for a certain specialization of our school courses with reference to the different demands made upon the schools by different classes of pupils. That our schools of primary and secondary grade, as they stand to-day, do not respond to the varied requirements of American society, seems quite obvious. The complaint of President Eliot sufficiently indicates their shortcomings, so far as a preparation for college is concerned. For many years professors and teachers at scientific and technical schools have mourned the dearth of preparatory schools that should give them pupils not handicapped by great deficiencies in training of the powers of observation. Business men are quite unanimous in their belief that the schools do not afford a satisfactory training for commercial pursuits, while he who runs may read their many deficiencies for the constantly increasing class of pupils whose period of school life terminates in the grammar grade.

The main cause of the present stage of development of the school system is not so deeply hidden that one has to search long for it. The average American school programme at the present time is simply a living illustration of a development, on American lines—influenced and modified by national characteristics—of the old educational theory that literature and language are the basis of all mental culture and training. The educational structure reared on this theory, beset and more or less damaged by modern assaults, has been repaired here and patched there, but the old framework and the old foundations have ever remained to cramp intelligent reconstruction and practical reform. The result is in the main a hotchpotch with which no one is thoroughly satisfied. It would seem to be a clear case of the old house repaired and refurnished, until it is satisfactory to no one. It is passing strange that the school system of the United States, in respect to its want of specialization, should stand almost unique among the many examples of the national aptitude in adopting means to ends. In business life, in professional life, in industrial pursuits, our nation has shown itself peculiarly clever in its concentration of labor in systematic, well-defined channels having special reference to the results to be attained. Yet, when we come to compare our school programmes with those of other nations, we not only find that we do not do as much school work,

nor as satisfactory work, but that what we do is done in an antiquated and unscientific manner. In France, for example, we find a school system that in its superior primary course gives to the child of the humblest artisan not only a solid foundation in all essentials of mother-tongue instruction, but, by means of its complementary courses, in manual training and modern languages as well. We likewise find a clean-cut, well-defined course in the special secondary schools for the child who seeks preparation for commercial or professional life by modern methods; while, by the systematic arrangement of its classical lycée course, results are achieved which excite the admiration and envy of the president of one of our most honored universities. Turning to our own programmes, we find what can only be characterized as a more or less futile effort to build on one foundation several distinct structures, each one of which is diverse in the special ends sought to be accomplished. In our effort to do everything, we have failed to do anything sufficiently well to entitle it to favorable comparison with the results attained by a more skillful apportionment of labor.

We can also learn from the French programmes that if American schools are to accomplish results comparable with those attained in France, American children have not only to work on more specialized lines, but have also to work more. There can be no doubt that the outcry against "long school hours" and "home study," which for many years past has been so resonant in this country, has seriously affected the efficiency of our schools. As the exhibit of school programmes here given shows, the average hours of recitation in American fitting schools are very considerably less than in those of France. And those of France are to about an equal degree less than the hours of the German gymnasia and Realschulen. It is full time that a halt be called on the further progress of this absurd clamor. The idea that a healthy American boy, between the age of eight and fifteen years, let out of school, as he generally is in these days, at from one to two o'clock, should not do a certain amount of systematic study at home, certainly can but be characterized as absurd. It is probable that but few persons, who have not made special inquiry in regard to it, appreciate the extent to which this sentiment against out-of-school study now prevails in this country. If it has had the effect of crippling the public schools, it may be said that it has really paralyzed many private ones where this feeling is pandered to. The advanced age of pupils entering the private fitting schools, as well as the advanced age of college matriculates, is to a great extent due to this disinclination of parents to submit their children to regular systematic study in their earlier school life. In collecting the data for this paper the writer has been pleased to

ascertain that on the part of certain endowed home fitting schools established on recent foundations, direct efforts are being made to counteract these deficiencies of earlier years by a systematic regulation of pupils' time—both as regards study and recreation. The result, as could be anticipated, is a marked broadening of the school course, as well as a decided decrease in the ages of the senior class pupils. It is because of the possibilities in this direction, as well as to respond to the rapidly increasing demand in the United States for them, that thoroughly good preparatory home schools, which shall fit boys for college and scientific school in a rational manner, are now especially in request. The average home school that fits for everything or anything, and that is a fraud from its glossy catalogue to its ornate diploma, is sufficiently well known to the average parent, and is not here alluded to. The home schools now needed to meet our modern requirements can have an existence only by virtue of some man or men willing to liberally endow them. It would seem, too, that the ideal preparatory home school should embrace at least six years of instruction. It should be fully equipped and prepared in all respects to respond thoroughly to the three distinct demands that are now made upon the modern fitting school, viz.: (1) preparation for college with all the maximum requirements in the classics; (2) preparation for college without Greek, but with adequate modern language and science-study substitutions; (3) preparation for the scientific school without Latin or Greek, but with equivalent and honest substitutions of somewhat increased mathematical instruction (as compared with the classical branches), together with modern languages and science studies, so taught that in all respects of severity of course they shall equal in disciplinary results the drill given in the classical courses.

To the response that may be made, to the effect that we already have preparatory schools doing precisely this work, and doing it well, it is claimed that the few facts presented in connection with this paper are in themselves a sufficient refutation. There is another point. The writer would be among the last to impugn the ability, the conscientious devotion, the peculiar fitness, even, of the heads, and, generally speaking, of the staffs of these classical schools, for he has the highest appreciation of them. But the fact remains that, with hardly an exception, the faculties of the old classical preparatory schools that have been erected on the old endowments seem to be incapable of giving absolutely fair and honest treatment to their so-called preparatory scientific or English adjuncts. They are bound hand and foot in the old traditional bonds. By reason of their educational bias they are precluded from yielding a hearty, enthusiastic response to any demand that a classical curriculum does not meet. In point of fact, why should

they? They have personally no faith whatever in the real value of any training except that gained by the study of the classics. They appreciate that the scientific course is but a graft on the old trunk, made in great measure for the pecuniary advantage of their establishment, and in response to a popular demand, which they hope and pray may soon find a speedy death. They have no hesitation in proselytizing in the ranks of the brighter "scientific" pupils sent them, for the benefit and glory of the "full rounded course"—in embryo. Here again they are justified, for the preparatory scientific courses are in fact but indifferent patchwork compromises between the claims of the past and the demands of the present. These courses really do give no thorough secondary school work in any one subject, except possibly mathematics. With an apparently semi-superstitious feeling as to the mysterious results produced on the human mind by communion with a Latin grammar, for even a limited period, little dabs of Latin have been introduced into these courses. This study extends in the scientific course of some preparatory schools through one year, sometimes two, rarely three years. With no desire whatever to depreciate the undoubted value, to certain pupils, of an honest, *bona fide* study of the classical languages, continued for years, it is submitted that these cursory courses of Latin can give no results in any way commensurate with the time expended on them. In Germany the classicists have ever stoutly maintained that any reduction of hours devoted to Latin in the gymnasium course would deprive it of all value; yet they there give to it nine hours per week for five years, and eight hours for four years more. In the Realschulen they devote to it eight hours a week for two years, six hours for three, and five hours for four years. The value that the German school authorities would place upon a course of Latin of three or four hours per week for one, two, or even three years, affords a pretty little arithmetical problem whose solution is respectfully relegated to the designers of these American courses. Beyond this Latin and the regulation four or five hours a week in mathematics, what else does one find in our preparatory "scientific" courses? As but few of the more modern scientific schools or schools of technology have requirements in Latin—and as one and all of them are desirous of obtaining from their matriculates all, and more than they often get, in the way of modern languages—one could properly expect that the fitting schools would afford opportunities for solid preparation in French and German. As will be seen, this demand is by no means well responded to. In the scientific courses of one prominent fitting school consulted by the writer, no instruction whatever in modern languages is given. In the programme of another of these schools—which is also the most modern, therefore leading some

encouragement to the hope of more enlightened procedure as time rolls on—we find that modern languages enter into but three of the four years' course. Leaving the modern languages, and looking at the time devoted to science studies, the same desultory treatment is found. There is encouragement to be had in the assurances of laboratories erected and in course of erection, and in the information that in some fitting schools Harvard's requirements in experimental physics and chemistry can be fully met; but, so far as the curriculum itself of the scientific course is concerned, we have but the hope of something better in the future. If one glances at the time allotted to the education of the hand by means of drawing, or if one is curious in the matter of history and mother-tongue instruction, almost equally unsatisfactory work is encountered. Very properly, any intelligent parent, studying such courses with a view of submitting to one of them a boy whom he has decided to educate on modern methods, hesitates. It is not strange that in his extremity he finally concludes that a serious, well-defined course in the ancient languages is of more value than the *olla podrida* preparation presented him on the "scientific" side. As this is precisely what the makers of the programmes themselves believe, this conclusion is applauded—and there is rejoicing over the rescue of another boy from a "one-sided education"!

A comparative examination of French and American preparatory school programmes, therefore, at least yields this much; that our educational methods are in great need of thorough revision if we are to hope to stand well alongside the French in all that pertains to judicious preparation for college, for scientific school, or for the general demands of modern life. This examination further shows that we stand in pressing need not only of fitting schools that meet these demands as they exist to-day, but so untrammeled and free from all sort of sectarian or educational bias that they can freely expand and respond to the demands that will assuredly follow as years roll by, and colleges and universities still further yield to the influences that are slowly but surely liberating them from the traditions of the past. An honest home fitting school, firmly founded on the principle of responding to the demands as they exist to-day—not as they existed a century or two ago—sufficiently endowed to render it free to maintain firmly all the requirements of its different rational courses of instruction, seems to be the great educational need of the day. As the weakest link of our educational chain lies most undoubtedly in the earlier years of the preparatory course, this school should be prepared to take pupils at twelve years of age; it would be better if they could be taken at ten, and the course be made to embrace eight years instead of six. It should be a home school, for the reason that, with

the prevailing habits of American family life, it is becoming with us every day more and more impossible to obtain from pupils the proper amount of work, associated with the proper *régime* as to exercise and recreation—and diet even—so long as they remain under the parental roof. Such a school could not fail to soon stand as an exponent of the development of a higher, better, and truer secondary education. It would be a model for the encouragement of other schools of a similar character that would soon come into existence, and it would make its impress upon the programmes of public secondary schools. Any man of wealth who is animated by the ambition of sending his name down to a grateful posterity linked with a noble educational benefaction, could not to-day find a more deserving field for the investment of a spare million than in the founding of such a school. To the colleges, to the universities, to the schools of industrial science, would the money thus invested be of as great benefit as if donated directly to them. For, as the gentle rain sinking far down into the earth among the rootlets refreshes and revives the mature tree, so would a preparatory school of this character give to the higher institutions of learning strength at a vital point where it is peculiarly needed.

SCENES ON THE PLANET MERCURY.*

By G. V. SCHIAPARELLI,
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NO one of the planets that were known in ancient times is so difficult to observe as Mercury, and none presents so many obstacles to the study of its orbit and physical constitution. As to its orbit, Mercury is the only planet the course of which seems even now to have partly cut loose from the laws of universal gravitation, and the theory of which, although well built up by the genius of Leverrier, is still in considerable disagreement with the observations. The little we know of its physical construction is derived from the observations made a hundred years ago by Schroeter at Lilienthal. A telescopic examination of this planet is really a difficult affair. Describing a small orbit around the sun, Mercury is never seen so far from it as to make it possible to observe it, in temperate latitudes, in the full darkness of night. It is rarely possible to observe it in the twilight before sunrise or after sunset; it being then so near the horizon and so affected by the agitations and unequal refractions of the lower strata of the atmosphere that it usually presents itself to the telescope with

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an uncertain and flaring aspect which appears to the naked eye as a strong scintillation. For this reason the ancients called it Στίλβων, or the scintillating star. No other resource is left than to essay observations in broad daylight, in the presence of the sun always near, and in an always illuminated atmosphere.

Some efforts I made in 1881 persuaded me that it was possible both to see the spots of Mercury and to get sufficiently connected and continuous observations of them in broad daylight, and I decided in the beginning of 1882 to make a regular study of this planet. During the eight years since then, I have had Mercury in the field of my telescope several hundred times; often, it is true, with little profit and at the expense of great loss of time, either because of the agitation of the atmosphere, which is often strong during the day—especially in the summer months—or on account of the insufficient transparency of the air. But by patience I have succeeded in seeing the spots on the planet one hundred and fifty times with more or less precision, and in making also fairly satisfactory drawings of them, employing at first, for the purpose, our eight-inch Merz equatorial, but afterward our great eighteen-inch Munich instrument.

I found the rotation of the planet quite different from what it has hitherto been supposed to be, on the basis of insufficient observations made with imperfect telescopes a hundred years ago. I may describe it in a few words by saying that Mercury revolves around the sun in the same manner as the moon revolves around the earth. As the moon's journey around the earth is performed in such a way that it always shows nearly the same face and the same spots, so Mercury, in traversing its orbit around the sun, constantly presents nearly the same hemisphere to that source of light. I say nearly—not exactly—the same hemisphere. For Mercury is subject, like the moon, to the phenomenon of *libration*. In observing the full moon, even with a small telescope, we remark that the same spots generally occupy the central regions of its disk; but, if we study them and their distances from the eastern and western borders more minutely, we shall soon perceive, as Galileo first did about two hundred years ago, that they oscillate to a considerable degree, now toward the right and now toward the left—exemplifying the phenomenon called *libration in longitude*. This arises from the moon's directing one of its diameters perpetually and almost exactly, not toward the center of the earth, and not toward the center of the elliptical lunar orbit, but toward the one of the two foci of its orbit which the earth does not occupy. To the observer occupying this point, the moon would consequently always present the same appearance. But to us, who are at a mean distance of forty-two thousand kilometres from that point, the moon presents somewhat different aspects

according to the time when we look at it, sometimes showing us a little more of its eastern, sometimes a little more of its western, regions. Mercury presents itself to the sun in different phases of its cycle in a similar manner. It constantly directs one of its diameters, not toward the focus of its elliptical orbit which is occupied by the sun, but toward the second focus. These two foci being distant from one another not less than a fifth of the whole diameter of the orbit of Mercury, the libration of the planet is enormous. The point that receives the rays of the sun vertically changes its place on the surface of the planet, and performs an oscillatory movement along the equator forty-seven degrees in amplitude, or through more than one eighth of the equatorial circumference. The whole duration of this oscillation, including the going and returning, is equal to the time employed by Mercury in traversing its orbit, or about eighty-eight terrestrial days. Thus Mercury stands oriented toward the sun like a magnet toward a mass of iron; but this orientation is not constant to the point of excluding a movement of oscillation of the planet to the east and to the west, like that which the moon performs toward us.

This oscillation is of great importance for the physical condition of the planet. Suppose, for instance, that it did not exist, and that Mercury always turned the same hemisphere to the light and heat of the sun, the other hemisphere remaining plunged in perpetual night. The point of the surface situated at the central pole of the illuminated hemisphere would have the sun eternally in the zenith; the other points of the planet accessible to the solar rays would have the sun always at the same point in their horizon, at the same height, without any apparent movement, without any perceptible change; consequently, no alternation of night and day, no variety of season; the stars eternally invisible because of the perpetual presence of the sun; and, Mercury having no moon, we can hardly imagine how the inhabitants of those regions, condemned to an endless day, could find a means of regularly computing time.

Such are, in fact, nearly the conditions that prevail in Mercury, but only approximately. The oscillating movement of the Mercurial globe as toward the sun would be attributed by an observer on the surface of the planet to the sun, as we attribute to the sun the diurnal movement which really appertains to the earth. To us the sun seems to circle regularly from east to west, defining in twenty-four hours the period of day and night; to the observer on Mercury, the sun will describe a back-and-forth movement through an arc of forty-seven degrees in the celestial vault, while the position of the arc as toward the horizon will always be the same. The complete period of the double oscillation will com-

prise almost exactly eighty-four terrestrial days. According as the arc of solar oscillation is all above the horizon of the observer or all below it, or partly above and partly below it, there will be different appearances and a different distribution of light and heat. In the regions, covering three eighths of the planet, where the arc is all below the horizon, the sun will never be seen, and the darkness will be perpetual. Thick and eternal night will reign there, except perhaps from the accidental appearance of some light produced by refraction and atmospheric glows, or phenomena like the aurora borealis; together with the light emitted by the stars and planets.

Another part of Mercury, including also three eighths of its surface, will have the arc of oscillation all above its horizon, and will be continually exposed to the rays of the sun, without any other change than the variations in the obliquity of the rays through the different phases assumed during the period of eighty-eight days. Night is absolutely impossible. In other regions, covering a quarter of the planet, in which the arc of oscillation is partly above and partly below the horizon, there will be alternations of light and darkness. In these privileged regions the period of eighty-eight days will be divided into two intervals, one characterized by a continuous light, the other by darkness; the two intervals will be equal in some places, of different length in others, according to the position of the place on the surface of the planet, and the length of the part of the solar arc which appears above the horizon.

The possibility of organic life in a planet constituted after this manner depends on the existence of an atmosphere capable of distributing heat into different regions, in such a way as to diminish the extremes of heat and cold. Schroeter, a hundred years ago, suspected the existence of an atmosphere round Mercury; my observations afford more definite indications of it, and affirm its existence with a much greater probability. The spots of the planet are most clearly visible when they are in the central parts of the disk, and grow dimmer and ultimately disappear as they approach the border. I have been able to assure myself that this phenomenon is not merely due to the greater obliquity of the perspective, but is because some obstacle is really presented to the view of spots situated in such positions. That obstacle can hardly be anything else than the greater extent of atmosphere that the light-rays have to traverse in coming from the edges than from the center of the disk. We have, therefore, reasons for believing that the atmosphere of Mercury is less transparent than that of Mars, and more nearly like that of the earth. The circular contour of the planet, moreover, in which the spots become less visible, always appears more luminous than the rest, but often irregularly

luminous, more so at some points than at others; and sometimes we can see on its borders bright white regions that remain in sight several days in succession, but are generally changeable, and show themselves sometimes in one place and sometimes in another. I attribute these phenomena to condensations going on in the atmosphere of Mercury, which reflects more light into space the more opaque it becomes. Similar white regions are also often seen in the interior of the disk, but they are not so brilliant there as on its border. Further, the dark spots of the planet, while they are permanent as to form and arrangement, are not always equally evident. They are sometimes more intense, at other times paler. Sometimes, also, one or another of them will become momentarily invisible. Such peculiarities can not be attributed to any other cause than atmospheric condensations similar to our clouds, which veil the ground of the planet in different degrees, sometimes in one region, sometimes in another. An observer, looking from the depths of space upon the countries of our earth covered with clouds, would perceive a like spectacle.

Very little can be said of the nature of the surface of Mercury. We must recollect that three eighths of it are inaccessible to the solar rays and to sight; on that side, therefore, we have but slight hopes of ever learning anything certainly. It will also be hard to gain a correct and sure knowledge of the part we can see. The dark spots, even when they are not clouded, usually appear under the form of extremely thin trails of shadow. In ordinary conditions they are distinguishable only at the expense of much attention and weariness. Under the best conditions they have a brown, warm tint, like that of sepia; of a tone very indistinct upon the general color of the planet, which is usually of a clear rose bordering on copper. Forms or bands so vague and diffuse, with indistinct borders, always leaving a place for arbitrary definition, are not easily represented in a satisfactory manner. Still, I believe the indeterminateness of outlines is, in the majority of cases, only apparent, and a result of the insufficient optical power of the instrument; for the more perfect the view and the finer the image we get of the shadows, the more do we find them disposed to break up into a multitude of smaller details. By employing more powerful telescopes, they could doubtless be resolved into more reduced forms.

While it is so hard to make a good study of the dark spots of Mercury, it is not easy to express a well-founded opinion upon their nature. They might be attributed to the different materials composing the solid surface of the planet or to its structure, as we know is the case with the moon. But if we are disposed to consider them as in some way resembling our seas, and to suppose the existence of an atmosphere around the planet, with condensa-

tions and precipitations, I do not know of any decisive arguments that can be opposed to the opinion. The spots are not gathered in large masses, but are disposed in areas and zones of small extent; are greatly ramified, and alternate with considerable uniformity with clear spaces. We may, therefore, conclude that no vast oceans or great continents exist on Mercury; but that land and sea interpenetrate one another and give rise to conditions very different from those which exist on the earth, but which may be more desirable.

Mercury is a world that differs from ours as much as Mars does. The sun lights it and warms it much more intensely than it does the earth, and in a very different way. If life exists in that world, it is doubtless under conditions so different from ours that we can hardly imagine them. The eternal presence of the sun, darting its rays almost vertically on some regions, and its perpetual absence in the opposite countries, would seem intolerable to us. And yet, if we reflect upon it, we shall remark that such a contrast would produce a more rapid, more powerful, and more regular atmospheric circulation than that which spreads the elements of life over the earth; and it possibly is brought about in this way that as complete and even perhaps more perfect equilibrium of temperature is produced on the whole planet than with us.

Mercury, by directing the same face toward the sun during its whole revolution, is peculiarly distinguished from the other planets, all of which the length of whose rotation has been determined, turn round their axes in a few hours. This mode of rotation, however, which would be unique among the planets, seems common enough among the satellites. All testimony is to the effect that our moon has always conformed to it. The first three satellites of Jupiter probably behave in the same way, and the observations of Auwers and Engelmann demonstrate that the fourth does so. Cassini verified the same fact for Japhet, the eighth satellite of Saturn. It may, therefore, be considered the rule among the satellites, while it is an exception among the planets.

The exception may probably be attributed to the proximity of Mercury to the sun, and perhaps also to the fact that it has no satellites; and depends, I think, on the way Mercury was formed when the solar system took its present shape. The peculiarity constitutes a new datum to be added to those which astronomers will have to take account of in studying solar and planetary cosmogony.—*Translated for the Popular Science Monthly from a French version by* F. TERBY *in Ciel et Terre.*

ARTIFICIAL HONEY AND MANUFACTURED SCIENCE.

By ALLEN PRINGLE,
PRESIDENT OF THE ONTARIO BEE-KEEPERS' ASSOCIATION.

WE are often told that this is a scientific age, and the statement is undoubtedly true. The world now more than ever before looks to science as a secular if not a spiritual guide. However much their speculations may be questioned and controverted, the scientific book and the scientific man are popularly accepted as authority, at least on matters of physical and historical fact. The veracity of science therefore is, or ought to be, above suspicion. How careful, then, ought the teacher and exponent of science to be that his assertions are true; that his alleged facts are facts; and that even his speculations are free from the appearance of dogmatism! He needs to be especially particular when writing for the general public, for people untrained in science will accept his statements as expert testimony. Errors will thus be sure to mislead his readers, many of whom are without the knowledge that would enable them to discriminate between the true and the false in his assertions.

In The Popular Science Monthly for June, 1881, appeared an article on Glucose and Grape-Sugar, by Prof. H. W. Wiley. In that article the following unfortunate statement was made: "In commercial honey, which is entirely free from bee mediation, the comb is made of paraffin, and filled with pure glucose by appropriate machinery." To say that there was not one word of truth in that extraordinary assertion is the short and proper way to put it, and that is exactly what I undertake to say. There was not a tittle of evidence that any such honey had ever been made up to that time, nor is there a particle of evidence that any such honey has since been made.

Nevertheless, this vile slander on an honest and honorable industry has done incalculable injury to bee-culture in America, if not throughout the world. A lie is said to travel half round the world while the truth is getting ready to start, and this one proved no exception. Though contradicted and refuted over and over again, it still lives and is still going. Newspapers still keep iterating and reiterating Prof. Wiley's slander, but they seldom publish a correction. Thousands of people, common and uncommon, still believe that scientific yarn that comb-honey is manufactured throughout without "bee mediation," and why shouldn't they? The former believe it because the newspapers say so, and the latter because the magazines and encyclopædias say so; for it is a fact that this itinerant fiction has actually found a place in

the American Cyclopædia and the American supplement to the Encyclopædia Britannica. In justice to the latter, however, it must be said that the British work, whose publishers repudiate the American supplement, contains nothing of this.

Here is what the American Cyclopædia says on the subject: "Glucose is very extensively fed to bees, which eat it with great avidity, and store it away unchanged as honey. It is also put up directly in trade as honey—with which bees have had nothing to do—being put by means of appropriate machinery into artificial combs made of paraffin" (page 834, vol. viii, edition of 1883).

The American supplement to the Encyclopædia Britannica has this information on the subject: "Honey is manufactured on the same plan, only here the bees are employed to assist in the fraud. They are furnished with a supply of starch-sugar, which they store in their combs, when these combs are also fraudulent, being made from paraffin and furnished to the bees, who fill them with glucose and cap them with genuine wax. It is difficult to see how the art of adulteration could be carried further" (page 41, vol. i, Hubbard Brothers, Philadelphia and New York, 1885).

Argument and refutation failing to kill the falsehood, the editor of Gleanings in Bee-Culture—a responsible man financially—offered a reward of one thousand dollars to any one (including Prof. Wiley) who would produce some of the so-called "manufactured" honey, or designate the place where it was made or could be found. This offer is still open and good. The writer of this article also offered through the press a reward of one hundred colonies of bees (equal to about one thousand dollars) to any one who would produce some of this "artificial honey." This offer also is still open and good. None, however, has ever been produced. No one has yet come forward to claim the cash or the bees.

Prof. Wiley had supplemented the assertion above quoted with the following additional information, probably to encourage the manufacturers: "This honey" (that is, the manufactured article) "for whiteness and beauty rivals the celebrated real white-clover honey of Vermont, but can be sold at an immense profit at one half the price." Now, had that business of honey manufacture been as practicable as profitable, the temptation to embark in it would have been almost too much for human nature to resist. But it seems nobody went in, while nearly everybody believed that other bodies were in.

However, Nature's dearth is likely to produce conviction where facts, arguments, and rewards failed to do so. The seasons of 1887 and 1888, especially the latter, were unpropitious for the "busy little bee," and yielded but little honey. The crop was a

general failure, not only in America but in Europe. The modicum of honey produced, especially of comb-honey, was soon exhausted, and the dealers as well as consumers, North, South, East, and West, were crying out for honey. The producers were inundated with letters and orders which they could not fill. Now, here was *the* grand opportunity for the manufacturers of "artificial honey." If the article could be sold "at an immense profit at half the price" of the genuine article, as Prof. Wiley assures us, these bogus manufacturers could have coined money—there were "millions in it" apparently. But they failed to appear. The glucose was available, the paraffin ditto, and the "appropriate machinery" ought, in the interval under the law of progress, to have become still more "appropriate" and perfect in its work; but, strange to say, the famine of honey continued. The tempting prices were offered in vain. Not a pound of the stuff ever "materialized," so far as anybody could find out. Nor was this gap in the extracted honey, caused by the drought, filled by any artificial substitute, which also goes to prove that the prevalent notion that honey is extensively adulterated has very little foundation in fact. Considering the comparatively low market prices of honey the past few years, and the facility with which the genuine article can be produced in modern scientific bee-culture, adulteration would hardly pay for the trouble.

That there is but very little adulteration either of comb or extracted honey may be safely asserted. The prevalent popular belief to the contrary may be accounted for in two ways—by the prevalent ignorance of the character and what I might call the habits of honey, and by the erroneous teachings and misleading reports of the authorities under review. While it may be said, in general terms, that honey chemically consists of sugar and water, in the proportion usually of about seventy-five per cent of the former to twenty-five of the latter,* these elements vary so much in their proportions in different grades of honey gathered from so many different flowers at different seasons of the year that there is no sure test, chemical or other, of honey. Even the polariscope, but recently considered a certain test of its purity, and still so considered by some analysts, is found to be uncertain and unreliable. While generally in pure honey the ray of light is turned to the left, some samples, equally pure, though perhaps stored rapidly and capped prematurely, may contain so much cane-sugar that the ray is turned to the right. Hence the mistakes of chemists, relying upon the integrity of the polariscope, in passing upon the purity or impurity of honey. They have

* According to C. Tomlinson, F. R. S., F. C. S., dextrose thirty-eight per cent, levulose thirty-six, water twenty-two, and the remaining four, salts, wax, pollen, gluten, and aromatic and coloring matters.

pronounced samples adulterated which were known to be the pure products of the flowers gathered by the bees. Every apiarian specialist knows that during the course of one good honey season, beginning with the early spring bloom of willow, maple, fruit, etc., and ending with the fall bloom of golden-rod, buckwheat, etc., he can get nearly a dozen different grades or kinds of honey—in color from the very light, almost transparent linden to the turgid and black buckwheat, and in flavor from the mild and delicious sweet to that which is strong, rank, and quite unpalatable to some tastes. Let a person with no special knowledge of honey be presented with the former for his sight and palate, and then with the latter, and, ten to one, he will declare that the one sample is not honey at all, but a vile imitation. Then, again, good, pure honey, through mismanagement, may become so deteriorated in quality and altered in taste as to at once provoke suspicion of adulteration.

Granulation was also regarded as a sure test of the purity of honey, but it is not so, as some pure grades, containing only the non-crystallizable sugar, will not granulate; while other samples mixed with glucose will granulate. The light-colored and best grades of honey will be fine-grained in granulation, while other grades will be coarse-grained and present the appearance of sugar for certain to the uninitiated.

When an honest man falls into an error, he is always willing to correct it as soon as it is pointed out to him and proved to be such. Prof. Wiley was expected to do that much at least toward repairing the injury he had wittingly or unwittingly done the whole fraternity of bee-keepers. But Prof. Wiley failed to do so, so far as the public knows. He neglected—I may safely say refused—to make the *amende honorable*. The apiarists became incensed, indignant, and demanded proof of his assertion or a retraction. The professor of science vouchsafed neither the one nor the other. Finally, after years had elapsed, being still hotly pursued by the apiarists and bee journals, especially the American Bee Journal, Prof. Wiley did manage to make an explanation or "statement"; which, however, in no way improved his position before the public either as an honorable man or a professor of science. About seven years after uttering the slander to the world, he speaks, and makes this astounding admission:

"At the time, I repeated this statement more in the light of a pleasantry than as a commercial reality, for I did not believe that it was possible commercially to imitate the comb." (Letter dated Washington, D. C., May 29, 1888, addressed to W. M. Evans, and published in the American Bee Journal of June 13, 1888.)

In this attempted justification of himself Prof. Wiley says he had heard from a friend of his (now deceased) that comb-honey

was manufactured in Boston as stated above. On the strength of that, and that alone, he made the deliberate assertion which I have quoted from The Popular Science Monthly.

Now, after reading and re-reading the context in The Popular Science Monthly article, I find not a shadow of evidence that this statement was meant for a fiction and not for a fact. It is given seriously and deliberately, along with other alleged scientific facts, with no intimation or indication whatever of its spurious character. The readers (and no doubt the publishers) of The Popular Science Monthly accepted the statement in good faith as a fact. The newspapers, of course, accepted it as true from so respectable an authority as The Popular Science Monthly, and even the encyclopædias finally took it in. Indeed, nobody, it seems, took it as a fictitious "pleasantry," or even dreamed it was meant for one, till the exigencies of the case required such a construction (or misconstruction) from the author himself. If it really was meant as a harmless scientific squib, with no *malice prepense*, the question arises, How is it that the professor neglected to set the matter right when he found that everybody was taking his joke seriously, to the great detriment of an important industry, and the calumnious aspersion of honest honey-producers?

Another example of spurious science is now before me. The Medical Standard for June, 1889, contains a leading article on Embryology, by a learned New York doctor, in which we are gravely informed that "a worker bee is a highly organized creature, with a well-developed brain, wonderful sense-organs, intricate muscular apparatus, and yet it is an offspring of an unimpregnated queen bee." Now, this is all well put and quite true, except the last clause, which is just the opposite of the truth. Any apiarian specialist could have told the doctor that while it is true that the virgin queen bee lays eggs which produce drones or males, she never deposits eggs which produce females—that is, workers and queens—until after she is impregnated by the drone. Hence, the worker bee is *not* "an offspring of an unimpregnated queen bee."

While it would be obviously unfair and unreasonable to hold the Monthly morally responsible for the specimen of *wily* science and its results to which this article refers, it is, perhaps, not entirely free from blame in allowing the matter to rest uncorrected so long. I take the liberty of here suggesting to publishers of encyclopædias and scientific works the wisdom of first submitting doubtful points and dubious assertions, made by men outside their special departments, to *practical* men in such departments, whether the latter be learned or unlearned, for the knowledge of an unlearned man touching his own particular line of business

(even the science of it) may exceed that of the scientist both in accuracy and extent. Such a course would often save the specialist from humiliation, and spare the public the infliction of some very queer science, which, not infrequently, fails to dovetail with every-day facts.

WALLACE ON "DARWINISM."

By the LORD BISHOP OF CARLISLE.

I HAVE read with deep interest, as doubtless have many other persons, Mr. Wallace's volume entitled Darwinism, which appeared in the month of March last year. No one has a higher right to teach the world on this recondite subject; and when it is borne in mind that Mr. Wallace was himself an independent discoverer of the principle associated with the name of Darwin, and that, nevertheless, no sentence indicative of rivalry or jealousy—in fact, no sentence laying claim to original discovery—occurs throughout the book, it is impossible not to be struck with a feeling of reverence toward a writer who combines such remarkable ability with no less remarkable modesty. Reference is made to this point in an article in the Contemporary Review (August, 1889) by Prof. Romanes, who writes thus:

> It was in the highest degree dramatic that the great idea of natural selection should have occurred independently and in precisely the same form to two working naturalists; that these naturalists should have been countrymen; that they should have agreed to publish their theory on the same day; and last, but not least, that, through the many years of strife and turmoil which followed, these two English naturalists consistently maintained toward each other such feelings of magnanimous recognition that it is hard to say whether we should most admire the intellectual or the moral qualities which, in relation to their common labors, they have displayed.

Prof. Romanes further lays stress upon the fact that, whereas opinion has lately tended, as between the two naturalists, toward Wallace and away from Darwin, there is no sign of triumph in the book.

> If ever there was an occasion (writes Prof. Romanes) when a man of science might have felt himself justified in expressing a personal gratification at the turning of a tide of scientific opinion, assuredly such an occasion is the present; and, in whichever direction the truth may eventually be found to lie, historians of science should not omit to notice that in the very hour when his life-long belief is gaining so large a measure of support, Mr. Wallace quietly accepts the fact without one word of triumph.

It is very pleasant to read this record of forgetfulness of self in the feeling of complete devotion to the cause of science and of truth; possibly instances of such self-forgetfulness are not so uncommon as they are sometimes supposed to be.

But Mr. Wallace needs no compliments from me, and it is not for the purpose of paying them that I have taken pen in hand. My purpose is rather to commit to paper certain thoughts which have occurred to me during the reading of his most interesting volume, and which it may perhaps be worth while to record. It seems to me that the publication of Mr. Wallace's work affords an occasion for taking stock, as it were, of that which the author describes as "Darwinism." It is needless to say that in the author's use of the word there is nothing vague, much less disparaging, in this term. The term is used in a certain definite sense, and is intended to express, not evolution in general, but evolution by those special processes to which Mr. Darwin believed evolution to be due. It is, I think, manifest that much advantage may accrue even from a declaration at the hands of such an authority as Mr. Wallace of what "Darwinism" is; but, besides this, it is specially advantageous, now that a quarter of a century has passed since the great revolution in thought on this class of subjects commenced, that we should know what is the real position of the controversy; there has been sufficient time for the smoke and din of the battle to pass away, and we can now form a better estimate than was possible in earlier days of the actual result of the engagement. I propose, therefore, to offer some remarks upon Mr. Wallace's volume, chiefly from the point of view just indicated; observing in general that the conclusion which seems to me to be of chief importance is this—that while Mr. Wallace holds to Darwin's views in the most important particulars, he does not regard "Darwinism" as any explanation of some of the most important phenomena which the living world presents.

This observation, however, must stand on one side for the present. The point which must occupy us just now is the actual meaning of "Darwinism," upon which possibly not a few persons have somewhat hazy notions. Let me quote Mr. Wallace:*

> In order to show the view Darwin took of his own work, and what it was that he alone claimed to have done, the concluding passage of the introduction to the Origin of Species should be carefully considered. It is as follows: "Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate and dispassionate judgment of which I am capable, that the view which most naturalists until recently entertained, and which I formerly entertained—namely, that each species has been independently created—is erroneous. I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are the lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species. Furthermore, I am convinced that natural selection has been the most important, but not the exclusive, means of modification." It should be especially noted, adds Mr. Wal-

* Page 9.

lace, that all which is here claimed is now almost universally admitted, while the criticisms of Darwin's works refer almost exclusively to those numerous questions which, as he himself says, *will long remain obscure.*

Mr. Wallace then proceeds to explain precisely what is meant by *natural selection,* and what, therefore, the Darwinian theory really is:

> The theory of natural selection rests on two main classes of facts, which apply to all organized beings without exception, and which thus take rank as fundamental principles or laws. The first is the power of rapid multiplication in a geometrical progression; the second, that the offspring always vary slightly from the parents, though generally very closely resembling them. From the first fact or law there follows, necessarily, a constant struggle for existence; because, while the offspring always exceed the parents in number, generally to an enormous extent, yet the total number of living organisms in the world does not, and can not, increase year by year. Consequently, every year, on the average, as many die as are born, plants as well as animals; and the majority die premature deaths. They kill each other in a thousand different ways; they starve each other by some consuming the food that others want; they are destroyed largely by the powers of nature—by cold and heat, by rain and storm, by flood and fire. There is thus a perpetual struggle among them which shall live and which shall die; and this struggle is tremendously severe, because so few can possibly remain alive—one in five, one in ten, often only one in a hundred or one in a thousand.
>
> Then comes the question, Why do some live rather than others? If all the individuals of each species were exactly alike in every respect, we could only say it is a matter of chance. But they are not alike. We find that they vary in many different ways. Some are stronger, some swifter, some hardier in constitution, some more cunning. An obscure color may render concealment more easy for some, keener sight may enable others to discover prey or escape from an enemy better than their fellows. Among plants the smallest differences may be useful or the reverse. The earliest and strongest shoots may escape the slug; their greater vigor may enable them to flower and seed earlier in a wet autumn; plants best armed with spines or hairs may escape being devoured; those whose flowers are most conspicuous may be soonest fertilized by insects. We can not doubt that, on the whole, any beneficial variation will give the possessors of it a greater probability of living through the tremendous ordeal they have to undergo. There may be something left to chance, but on the whole *the fittest will survive.**

Upon this statement of what "Darwinism" is, coming to us as it does from the highest authority, certain observations suggest themselves.

In the first place, objection may be taken to the phrase, *the fittest will survive.* The phrase, if I am not mistaken, was not originally devised by Mr. Darwin, and seems open to criticism. For fitness implies something of moral superiority; you can not measure it in respect of length, or breadth, or strength, or any other quality capable of being tested by strictly physical conditions. Moreover, there is some danger of being betrayed by the

* Pages 10, 11.

phrase into the error of arguing in a circle; for, in the case of not a few creatures which have survived, it is difficult to give any good reason for their survival except upon the assumption of their fitness as proved by the very fact of their survival. Thus their fitness leads to their survival, and this survival leads to the conclusion that they must have been the fittest. Which is arguing in a circle. Still further, it is not difficult to suggest examples in which the expression, *survival of the fittest*, manifestly breaks down. Sir Isaac Newton was, as is well known, a very delicate child, difficult to rear. Suppose that Newton and a powerful navvy, or coal porter, or grenadier, had been compelled to rough it as children at Dotheboys Hall or some similar establishment, which would have survived? Not Newton; and yet it may be fairly argued that in many respects he would have been the fittest. Nor is this imaginary case an altogether unfair test of the propriety of the phrase; for it is impossible to give any true definition of fitness which shall exclude all moral and intellectual qualities, all qualities in fact which are of the highest value, and which shall simply include those elements of toughness and wiriness, and strength of sinew or stomach, which are chiefly calculated to prolong life in trying circumstances.

Putting out of consideration, however, the propriety of the language by which survival in the struggle for life, whether among vegetables or animals, is expressed, it is to be admitted that the principle indicated is a true one. That is to say, it may be regarded as admitted by all persons whose studies and natural powers render their opinion of any real value, that modification by natural selection is an element in that evolution of living forms of which the evidence appears to be irresistible. Natural selection is a vera causa; the question is, What is the extent of its action? how much can it do?

Darwin considered it necessary to supplement *natural* by that which he termed *sexual selection*; in doing which he was quite consistent, because he speaks (as we have already seen) of natural selection as "the most important, but not the exclusive, means of modification" of species. This supplemental hypothesis, however, does not commend itself to Mr. Wallace's judgment.

Mr. Darwin (he writes), as is well known, imputed most of the colors and varied patterns of butterflies' wings to sexual selection—that is, to a constant preference by female butterflies for the more brilliant males; the colors thus produced being sometimes transmitted to the males alone, sometimes to both sexes. This view has always seemed to me unsupported by evidence, while it is one which does not account for the facts.

Again, after explaining his own views on the subject of ornamental appendages of birds and other animals, he writes:

The various facts and arguments now briefly set forth afford an explanation

of the phenomena of male ornament as being due to the general laws of growth and development, and make it *unnecessary to call to our aid so hypothetical a cause as the cumulative action of female preference.*

Whether the views put forward by Mr. Wallace do in reality render unnecessary the Darwinian hypothesis of sexual selection will not be here discussed; it is sufficient to note that the conclusions of Mr. Darwin in this not unimportant matter have, after abundant time for examination and reflection, been rejected by the naturalist who more perhaps than any other has a right to criticise him.

But Mr. Wallace rejects also the evolutionist views of another very competent naturalist, Prof. Romanes; and it will aid in the development of the purpose of this paper if I refer in passing to this rejection. The theory of Prof. Romanes is described by him under the phrase *physiological selection;* it is not necessary in this place to explain what the theory is; it is sufficient to say it is regarded as highly important by Prof. Romanes, and as utterly unfounded by Mr. Wallace. It would be impertinent on my part to offer any opinion as between these two authorities; but the conclusion may be fairly drawn that there is probably much at present unknown in the subject of evolution, as well as not a little doubt with regard to some fields of inquiry into which our knowledge is supposed to extend.

But the most striking and interesting feature of Mr. Wallace's book, from what I may describe as the *human* point of view, is to be found in that part of his work in which he denies, and (as he believes) proves himself to be justified in denying, the application of the principle of natural selection to the evolution of the human faculties. This denial is a fact of the first order of magnitude; and I confess that I can see no ground for the language of strong depreciation in which Prof. Romanes, in the article already referred to, describes this portion of Mr. Wallace's book. He speaks of the substance of the concluding chapters as being "sadly like the feet of clay in a figure of iron, marring by its manifest weakness what would otherwise have been a completed and self-consistent monument of strength." No argument in the article justifies this condemnation; and it is, perhaps, not too much to say that many of his readers will find in the condemned portion of Mr. Wallace's book that which has the deepest interest for themselves, while it must not be forgotten that the views put forward are alleged by Mr. Wallace to rest upon proofs which he formally submits for examination. Let us see, then, what this clay formation contains.

Mr. Wallace fully accepts "Mr. Darwin's conclusion as to the essential identity of man's bodily structure with that of the higher mammalia, and his descent from some ancestral form common to

men and to the anthropoid apes." But he observes that "although perhaps nowhere distinctly formulated, his (Mr. Darwin's) whole argument tends to the conclusion that man's entire nature and all his faculties, whether moral, intellectual, or spiritual, have been derived from their rudiments in the lower animals, in the same manner and by the action of the same general laws as his physical structure has been derived." This conclusion Mr. Wallace considers to be "not supported by adequate evidence, and to be directly opposed to many well-ascertained facts."

I will not endeavor to reproduce the whole of Mr. Wallace's argument on this subject, but will present what appears to me to be the pith of it; and I do this with the greater satisfaction, because what is here advanced seems to harmonize with what I have already written in criticising the phrase *survival of the fittest.*

Let us confine ourselves, for simplicity's sake, to one human faculty, namely, the mathematical. The problem is, how to produce a mathematician by the process of natural selection. The reader must bear in mind clearly what the theory of natural selection is, as already expounded. It is the survival in the struggle for life of those individuals which possess variations from their fellows favorable to their preservation. In order, therefore, that the mathematical faculty should be evolved by the process of natural selection, it is necessary to suppose that those individuals, which have an advantage in the possession of rudimentary mathematical faculties somewhat in excess of their fellows, should be the survivors in the struggle for life. The mere possession of this rudimentary advantage must be an aid toward life preservation. This in itself is hard to understand; but it becomes harder still when we bear in mind the rareness of the mathematical gift. In our own time it would be perhaps an overestimate to say that the mathematical faculty existed in any marked degree in one per cent of the population; assume such a proportion to have generally held in human history, then it would be necessary to suppose that these rare specimens of rudimentary mathematical ability had some very decided advantage in the struggle for life: but what ground is there for such a supposition? Grant that ten men in a tribe of a thousand had discovered how to count upon their fingers, or suppose them to have discovered some elementary geometrical theorem, how would this help them when a neighboring tribe attacked them, or when famine and pestilence were abundant? It is difficult or impossible to say.

And the same argument would seem to apply to other human faculties, music and all forms of art, writing, even speech. Consider speech for a moment as the most universal and most dis-

tinctive of human faculties. Here the problem is just the reverse of that which occurred in the case of mathematics: in that the favorable variation to be preserved is rare, in this the variation scarcely exists; the faculty of speech is universal; how, then, can there be a survival of the fittest where all are equally fit?

It seems difficult to resist this kind of argument, and I should not be surprised to find the opinion gain ground, and ultimately become established, that while the human faculties have undoubtedly been developed gradually, the development can not in any way be traced to the process of natural selection.

But if it be once admitted that the principle of natural selection is inadequate to explain the development of specially human qualities, there is a temptation to go back to the consideration of the powers and instincts of some of the inferior creatures, and to inquire whether natural selection may not be inadequate also in their case, as in that of man. I confess that I have never been able to perceive how the principle can be brought to bear upon such phenomena as the architecture of insects—for example, that of bees and wasps. What, I suppose, ought to have happened is this, that some variation of an ancient form of bee made a rough approximation to a modern honeycomb, that they who made the best honeycomb were the fittest to survive, and that in this way by slow degrees and by natural selection a race of bees was produced capable of performing the geometrical wonders which modern bees perform. But there are two difficulties: First, in conceiving the original start of insects in the direction of architecture; and, secondly, in perceiving the connection between good architects and survival in the struggle for life. Certain bees might make their wax go further than other bees, and our actual bees use their wax with absolutely mathematical economy; but it is difficult to perceive how this economy is helpful in the struggle for life. Can we get over these difficulties? If it were a case of some device for self-preservation, the conclusion might be different. For example, if we can imagine some variation of a race of spiders devising, in ever so rough a form, those curious houses which have attained such perfection in the hands of the trap-door spider, we can also easily believe that this variation would be likely to survive, and that while less ingenious spiders became the prey of their enemies, those which were concealed in their cunning castles would escape. But there is nothing parallel to this in the case of wasps and bees; here we have a beautiful geometrical problem somehow solved, apparently without connection between the solution and the preservation of life. One of two conclusions seem inevitable—either the geometrical skill has belonged in its perfection to bees and wasps ever since those insects existed; or else the geometrical skill has been developed by some

internal law of growth, independently of all questions of natural selection.

There is another class of natural phenomena upon which Mr. Wallace writes much that is deeply interesting, but to which it may possibly be questioned whether the principle of survival by natural selection is applicable—namely, the phenomena of mimicry. Of course it is quite intelligible, to take an instance, that a living creature which is very much like a leaf will escape many enemies, and even have such an advantage in the struggle for life that many other living creatures would be like leaves if they could. But when we endeavor to go back in imagination to the commencement of the mimicking process, we must conceive of a creature not at all like a leaf, but among whose offspring there are certain individuals which have a slightly leaf-like appearance, and that these survive in preference to others not having the appearance in question. The conception involves two difficulties: First, the notion of certain individuals having a slightly leaf-like appearance is eccentric and hard to accept. It is different from that of individuals varying by length of leg, or strength of wing, or what not. It is a variation, so to speak, not of degree but of kind. And, secondly, it is difficult to see why a resemblance to a leaf, admitted to be slight, and therefore one would imagine not easily perceived, should be any substantial protection from enemies, and so an appreciable advantage in the struggle for life.

Similar difficulties occur with regard to other cases of mimicry. My space does not permit me to examine them in detail; but I have come to the conclusion that, while mimicry may probably be always connected with some advantage which it confers on the animal, it is difficult to conceive of the mimicking transformation being originally brought into operation by any process of natural selection.

This failure of the principle of natural selection to explain much that is connected with the evolution both of men and of inferior creatures may lead us to inquire, to what extent the principle satisfies etiological requirements even in those cases in which its application appears most complete. The modification and multiplication of species require three conditions to be postulated: (1) an original species; (2) the power of multiplying that species by reproduction; and (3) the occurrence of variations in the successive generations.

Now (1) the existence of the original living germ or germs must, I suppose, be left by universal consent in mystery. Mr. Darwin treated of the Origin of "Species," not the Origin of "*living things.*" This latter question is not likely ever to come within the reach of human science; certainly it has not done so yet. Given the existence of the material universe, or the existence of

living things, and there is abundance of opening for discovery with respect to the laws of matter and the laws of life; but matter and life must first be given: this is sufficiently obvious; but it is worth noting, because there is sometimes a tendency to make a confusion between creation and the laws of created things; whereas it is obvious that creation is one thing, and the law governing created things is quite another. But (2) as the original existence of living things is a mystery, so also is the reproduction of them. The continuity of life on the earth's surface, insured in various ways more or less resembling each other, and all agreeing in this, that there is apparently no tendency in vital power to degenerate or wear itself out in the course of ages, is, as it were, a standing mystery of creation. The scientific man has nothing to do with this mystery; to him it is simply a fact or phenomenon; but he who tries to go beyond phenomena and to get at the cause behind them will recognize reproduction as being etiologically equivalent to continuous creation. The great feature, however, of the principle of natural selection is (3) the occurrence of variations. Mr. Wallace lays great stress on the abundance of the variations which occur in nature, and the corresponding importance of this element in the Darwinian theory; and he is obviously wise in doing so. But it is well to observe that it is impossible to regard variations either on the one hand as a necessary feature of reproduction, or on the other as simply fortuitous. With regard to the latter supposition it is, certainly, difficult to conceive of chance as being a principal factor, say, in the production of a horse, to say nothing of a man. But even the former supposition is not quite an easy one: it is difficult to see why variations capable of being made permanent should occur, and why (if there be offspring at all) the offspring should not be exactly like the parent; in not a few cases this seems to be the law of living things. What I wish to point out, however, is this, that from the etiological point of view there ought to be a *cause* for variations as well as for other phenomena; and that, therefore, when we use the phenomenon of variations as a part of the machinery of natural selection, we do not get rid of the task of inquiring, as philosophers, why those useful variations occurred. In fact, in this as in many other instances, what is done is to shift the process one stage backward, but to leave the question of the primary cause very much where it was. Variations are abundant, says the student of natural history, and advantageous variations are preserved and made permanent by the process of natural selection: let it be granted. But the philosopher may still say: How comes it that advantageous variations should occur? Must not this occurrence be the result of some pre-established principle or law of development?

Take the case of the horse, which Mr. Wallace has dwelt upon

at some length, and has illustrated by a diagram. The evolution of the horse of historical times and of the present day from the *orohippus* of the Eocene period, as exhibited to the eye by Mr. Wallace's diagram, is as interesting a presentation of a physical pedigree as can well be conceived. We see, as it were, the progress of Nature's work; the transformation from several toes to one toe, which was, in reality, the operation of thousands of years, is visible as a connected continuous process from beginning to end. But what the diagram does not, and can not, put in evidence is this—namely, the marvelous beauty of the horse in his ultimate condition. So far as any conclusions can be drawn from the diagram, the top and the bottom of the page stand upon an equal footing; there would seem to be no reason why *orohippus* should not have been derived from *equus* by expansion, as easily as *equus* has been derived from *orohippus* by contraction. When, however, we look, not at the *equus* of science, but at the *horse* of the hunting-field or the race-course, or at our own stable friend, who has carried us safely for hundreds of miles, we perceive that, somehow or other, we have, in these modern days, an animal of the most perfect kind with regard to speed, beauty, and mechanical perfection. We feel convinced that it would be in every way a mistake that he should develop toes and become *orohippus;* we are sure that *orohippus* has rightly been improved off the face of the earth in order to make room for *equus*. All this is, in the best sense of the phrase, in accordance with the principle of the survival of the fittest; but I confess that I find it difficult to realize the transformation of *orohippus* into *equus* upon the pure and simple notion of advantageous variations in the struggle for life; for, in truth, if the question be one of mere survival, it is difficult to say, when the earth was inhabited by wild creatures, in what manner the possession of one toe instead of three or four should give *equus* any advantage over *orohippus*. One can quite understand that a jury of Newmarket jockeys would decide that *equus* was fittest to survive; but in the absence of human judgment the conclusion is not so easy to reach. At all events, it seems more probable that the transformation was originally ideally contained in the conception of this class of creature, and that *equus* may be regarded as bearing to *orohippus* something of the same kind of relation as is borne by a frog to a tadpole, or by a moth to a caterpillar.

May it not well be that predetermined transformation has as real a place in the genesis of species as it certainly has in that of individual creatures? Nothing, perhaps, strikes most minds as more surprising than insect and reptile transformation. That a crawling animal should, by a complicated process, involving a condition of motionless helplessness, be ultimately transformed into a creature of active life spent in flying through the air, or

that toads and frogs should find it necessary to pass through the fish-like life of tadpoles—this class of facts may well puzzle the thinking mind; but the advantage of them is that they *are* facts; no one can dispute them; and taking our stand upon them we may guess that the processes of Nature are analogous, in cases in which we can not distinctly prove that they are so. May it not be, then, that the Eocene period of creation presented a condition of things out of which a higher condition was evolved, not simply by the perpetuation of advantageous variations, but much more by virtue of an internal principle of growth, similar to, or at least comparable with, the principle which develops the fœtus or which transforms tadpoles and caterpillars? Adopting this view, we should have in both cases a limit toward which transformations tended; as the butterfly is the ultimate form of the caterpillar, and the caterpillar was the forerunner and necessary ancestor of the butterfly, so *equus* may perhaps be regarded as the ultimate form of *orohippus*, and *orohippus* as the forerunner and necessary ancestor of *equus*. At all events, this view of the facts seems to be tenable, and it is free from certain difficulties by which the hypothesis of natural selection pure and simple is undoubtedly beset.

The question of growth, evolution, development, by an internal power similar to, and comparable with, that which we see daily and hourly at work all round about us, leads to the discussion of another and very interesting question—namely, whether man can perfectly be described as "derived from the lower animals." The expression is Mr. Wallace's. He speaks of "man in his bodily structure" as having been "derived from the lower animals, of which he is the culminating development."* I venture to question whether this is a correct statement of the facts of the case. I am not venturing to throw doubt upon Mr. Wallace's scientific deductions; on the other hand, their correctness shall for the sake of argument, if on no other ground, be fully granted; all the more readily in consideration of the important limitations of the principle of natural selection made in the case of man, as already noticed and discussed. What I venture to doubt is, whether the process of human evolution, as accepted by Mr. Wallace, can be rightly described by the terms which he applies to it. Certainly there is something in the conception of such derivation from which the feelings of most of us not unnaturally shrink, and from which they would gladly be free, if freedom can be had consistently with scientific truth. There is something in it of that "letting the house of a brute to the soul of a man," of which Lord Tennyson sings in his most recent volume. It may be worth

* Page 454.

while, therefore, to consider whether the phrase, "derivation from the lower animals," is one which can be maintained as rightly expressing the truth which it is intended to express concerning the physical history of our race.

Now it is manifest that if we look back, so far as is possible, into the remote past, when the first germ of animal life appeared upon the globe, two conditions of things, and two only, are conceivable. Either (A) there was a single germ of life, from which all subsequent living forms have been evolved or developed; or (B) there were several or many germs of life, from which, in separate streams, so to speak, the evolution of living creatures took place. Mr. Darwin inclined, I think, to the latter supposition; but either A or B must be accepted by all evolutionists of all schools. Let us consider them successively.

A. If we make the supposition that living forms commenced upon the globe from a single germ, then it follows that all living creatures now existing—insects, fishes, birds, beasts, man—have been evolved by some process or processes from one and the same origin: whether the process of variation and natural selection be sufficient to account for the development, it is not necessary for the purpose of this argument to decide; it is sufficient to say, and this can scarcely be denied, that by some process or processes the development has taken place. Therefore, ascending to the hypothesis now under consideration, it will be true that the lower animals and man had a common origin; but this is manifestly a different thing from asserting that man is "derived from the lower animals." If we go up to the hypothetical origin of life, or the single germ, this latter assertion is obviously untrue, because, as by hypothesis there was then only one germ, there could be no distinction of superior or inferior; but if we stop short of the origin and observe the condition of things at any period subsequent to the hypothetical beginning, we shall find progress being made toward the development of man and simultaneous progress being made toward the development of the lower animals. But it does not follow that, because this simultaneous development is taking place, therefore we can say that one form of life is developed from the other; it might be as correct to say that the inferior animals were developed from man, as man from the inferior animals. Take an illustration from that which is possible in the case of rivers. Conceive of two rivers running into the sea; trace their course, and suppose that ultimately you come to the same source in the distant mountains; it would not be correct to say that one of these rivers was derived from the other. The correct statement would be that they sprang from one and the same source, that they had different histories, and that they terminated in different streams.

When we speak of the lower animals, do we not in fact postulate the existence of man? Lower than what? Surely lower than man: therefore inferiority can not be predicated until man's existence has been assumed, or has become a fact; and therefore to speak of man being derived from the lower animals in the remote past, when, if you only go far enough, there is no higher or lower, would seem to be a confusing use of language.

If it be urged that the objection now made to the phraseology used by Mr. Wallace is merely a verbal quibble, I venture to argue, on the other hand, that there is not a little importance in the objection. I quite admit that if the creation of man be a merely fortuitous fact, a lucky hit, so to speak, in the infinite variety of living forms developed from a single original living germ—if, in fact, creation be without the high purpose which human life, as distinguished from all other forms of life, seems to make manifest—it is scarcely worth while to argue the question whether man was derived from the inferior animals or not. But if man be the intended crown of creation existing in the determinate counsel and foreknowledge of God from the beginning, then it does seem to be worth while to argue that the derivation of man and beast from the same living germ is not the same thing as the derivation of one from the other. A sane man may have the misfortune to have an idiot brother; the sane man and the idiot are derived from the same parents, but it would be incorrect to say that one was derived from the other. May there not be some analogy between a case of this kind and the case of man and beast?

B. So much, then, for the hypothesis of one original germ of life; the argument becomes perhaps more simple if we adopt the second hypothesis, namely, that of several or many germs.

For in this case it is not unreasonable to suppose that specific differences existed among the original germs. I confess that the notion of the development of all forms of life from one original germ offers to my own mind an almost insuperable difficulty. The arguments drawn from the experimental facts of variation and natural selection, from the observed progression of animal forms in successive geological strata, and the like, seem to me quite inadequate to explain the development of insects, fishes, birds, mammals, from one stock. Consequently, to my own mind it is a relief to be able to think of several, and if of several then possibly of any number, of original germs. The hypothesis is not opposed to, but quite in accordance with, Mr. Darwin's own views; in fact, he was far too cautious a man to dogmatize concerning the unity of the origin of living forms, when all attempt at the examination of the question of origin would necessarily carry him far beyond the limits of possible experiment. Let us

then adopt provisionally the hypothesis of a multiplicity of germs of life; and if we do this, there is nothing wild or strange in the supposition that the germ of man was different from other germs. It would be beyond all that scientific caution would justify to assume that, given a number of original germs of life, it is matter of chance into what each will develop. It is contrary, I think, to the whole analogy of Nature to suppose that a living germ, which is to all intents and purposes an ovum or egg, may ultimately develop into an oak, or a fish, or a man, according to its surroundings or according to mere chance. At all events, it is much more probable, much more according to analogy, that each germ should have its specific character, and that so man should have been man in intention and preparation from the very beginning of things. It may have been—in fact, according to the supposition of evolution it must have been—that in the early condition of life upon the globe there was no man (in the full and proper sense of the word) in existence, but his progenitors would be there; and what is submitted is this, that those progenitors were undeveloped men, and not "lower animals." What they visibly were scientific discovery has not yet put in evidence; it is admitted that there is a "missing link" between the present and the past. Some scientific men hope that the link may be found, some think that it is hidden under the sea; but, whatever the truth may be with regard to this point, what is maintained is this, that, on the hypothesis of a multiplicity of original germs of life, it is more probable than otherwise that certain germs contained the promise of men, others of "lower animals"; and that, if so, it is incorrect to speak of the lower animals as the progenitors of men.

This view of the case, though founded upon a criticism of Mr. Wallace's language, would seem nevertheless to be consistent with his real views concerning the origin of man. In the last chapter of his work, entitled Darwinism applied to Man, to which reference has been already made, it is contended, as we have seen, that the principle of natural selection will not account for the development of the human faculties. I recur to that chapter chiefly for the purpose of making two extracts, which will, I think, tend to strengthen the arguments which have been already advanced. After rehearsing three stages of progress in creation—the change from the inorganic to the organic; the introduction of sensation or consciousness, constituting the fundamental distinction between the animal and vegetable kingdoms; and the existence in man of a number of his most characteristic and noblest faculties, those which raise him above the brutes and open up possibilities of almost indefinite advancement—Mr. Wallace writes thus:

These three distinct stages of progress from the inorganic world of matter and motion up to man, point clearly to an unseen universe—to a world of spirit, to which the world of matter is altogether subordinate.*

And again:

Those who admit my interpretation of the evidence now adduced—strictly scientific evidence in its appeal to facts which are clearly what ought *not* to be on the materialistic theory—will be able to accept the spiritual nature of man, as not in any way inconsistent with the theory of evolution, but as dependent upon those fundamental laws and causes which furnish the very materials for evolution to work with.†

Declarations such as these, coming from such an authority, must doubtless be very comforting to those minds which feel themselves compelled to receive the evidence for evolution but shrink from materialism, which feel convinced that materialism can not be true, and yet have an uneasy suspicion that evolution points to it as a logical conclusion. But if we admit with Mr. Wallace that variation and natural selection are not adequate to explain the evolution of man's higher qualities and faculties, we are not merely delivered from the acceptance of materialism, we are invited and even compelled (as has been urged in a former part of this paper) to review the whole question of the extent of the application of Mr. Darwin's great principle. He would be a rash man who, in the face of Mr. Darwin, Mr. Wallace, and the whole generation of naturalists who have followed in their steps, should deny that natural selection was a *vera causa* in creative work; but there is no rashness or audacity in maintaining what Mr. Darwin did not deny, and what Mr. Wallace emphatically affirms, namely, that there is needed for the explanation of phenomena something beyond, and essentially different from, the process of natural selection. All seems to point beyond matter into the region of mind, beyond mechanical sequence to purpose, beyond all *veræ causæ* to the *causa causarum*, beyond Nature to God.

I will close this paper by recording an incident which was communicated to me some years ago in the course of conversation by Dr. Thompson, the late Master of Trinity College, Cambridge.

Dr. Thompson was walking, in his college days, with two companions, one of whom was Alfred Tennyson; of the name of the other I am not sure. The path by which they went was one which all Cambridge men know, namely, that which leads from the backs of the colleges through the fields toward Coton. After passing the brook, which used to be crossed (and perhaps is now) by a rude wooden bridge, it was perceived that Tennyson had

* Page 476. † Ibid.

lagged behind. He had paused by the side of the brook, brought his eyes as near as he could to the surface of the water, and was examining with intense interest the subaqueous life which the little stream contained. After a time he rejoined his companions, and this was his utterance when he joined them: "What an imagination God has!" The words must have made a deep impression upon my informant's mind; otherwise he would not have retained them in memory, and would not have thought it worth while to repeat them to me. They made a similar impression upon myself when so repeated; and I can not but regard them as containing a true philosophy of Nature. Whatever may be the power of natural selection, and whatever causes may be at work to produce the varied scene of life which the world contains, you need some underlying cause, both of life itself and of reproduction and variation, and of all natural phenomena; and if causally the existence of the universe may be attributed to God's will and purpose, so the endless variety of vital manifestations may be attributed to that which in the case of man we should call imagination.

In reality, whatever may be the actual historical genesis of Nature, we seem to need a *quasi*-Platonic doctrine of antecedent ideas in the divine mind as the basis, the underlying condition, of the existence of things as we see them. It is matter for fair discussion among naturalists how much may be attributed to natural selection, how much to sexual, how much to physiological, and so forth. But such discussions can not go to the root of things; they do not reach the original thought out of which the works of Nature, as we call them, originally spring. Michael Angelo, as we are told, used to sit with his hammer and chisel before his marble block, and shape it without any previous modeling process into the figure which he intended to produce; other sculptors, I believe, with only this one grand exception, make their model in clay, and thence proceed by semi-mechanical steps to the finished work; but Michael Angelo and all other sculptors have alike the seminal idea in their minds, and the manner of its evolution is comparatively a matter of detail. Something of the same kind may be said of the production of natural things. It may be possible for naturalists to discover some of the steps by which the finished work comes to be what it is; but the actual origin of natural things—the wonders of life, the varied beauties of the universe, above all, the mind of man, which is capable of understanding, appreciating, and discussing the problems to which natural things give rise—is to be sought in no region lower than that which may, with all reverence, be described as the mind, or as the imagination of God.—*Nineteenth Century.*

CATS AND THEIR FRIENDSHIPS.

By W. H. LARRABEE.

I HAD for ten years a cat whose intelligence interested me greatly and was considered remarkable by all persons who took notice of her. Her confidence in her master and mistress, her evident enjoyment of their society, her happy faculty of putting herself upon an understanding with them, her familiar interest in matters of the household, the shifts and devices of which she was master, and her sagacity manifested in ways as various as the exigencies she had to meet, evoked frequent admiration and praise. These manifestations led me to look into the subject of knowledge in cats, and I have found that she was not singular, or even exceptional, in the quality of her faculties. She appears to have been a type to which a great many of the more happily trained members of her race can easily measure up. My observations have been naturally extended to other animals, and have led to the conclusion that most domesticated species and many wild ones are capable of and often manifest equally high degrees of mental development. But cats—and dogs too—are more at home with us, have more opportunities to learn, and come under closer and more constant observation than the others.

The cat belongs to a large and highly specialized family; to one that is clearly distinguishable from the other families of animals, while the resemblances between its own members is so strong that even the careless, unprofessional observer will hardly fail to assign at a glance an individual of any of its species to it. All the members of the family are, according to Wood, light, stealthy, and silent of foot, quick of ear and eye. They are exceedingly graceful in form and movement, have flexible bodies and limbs—walk, we might say, on tiptoe—are alert and swift in action, and are exceedingly cunning. Between many of them and the cat itself there is hardly any prominently visible difference except in size. Curious resemblances in features of line or expression may be remarked between the portraits of the *Felidæ* in Wood's Natural History and cats with which the observer is acquainted. A copy of the photograph of the head and breast of a tiger at rest, in a portfolio by our side, might be easily mistaken, except for a few differences in the shading of the hair, for a life-size portrait of the cat that has given the occasion of this article. St. George Mivart recognizes fifty living species of the cat family, forty-eight of which he includes in the genus *Felis*.

The history of the domestic cat has been traced back to the ancient Egyptians, among whom the earliest notices of it appear

on the monuments of the second empire of the twelfth dynasty (about 2400 B. C.), at Beni Hassan. It seems to have appeared there just after the Egyptians had made considerable conquests in Nubia, whence it may have been brought, already domesticated, among the spoils of war. The mummified cats in the Egyptian tombs are not identical with our house cat, but seem to belong to a native species (*Felis maniculata*, Fig. 1) which is said to be still indigenous in Nubia, where it is found on the western side of the Nile, in a stony district in which brushwood grows.

FIG. 1.—EGYPTIAN CAT (*Felis maniculata.*)

The domesticated animal was slow in making its way from Egypt into the neighboring nations. The Hebrews were apparently without it, and it is not once mentioned in the Bible. No evidence has been found that the Assyrians and Babylonians were acquainted with it. According to authors who have investigated the philological branch of the history, these people possessed a binary nomenclature for animals, with generic and specific names, and included their lions and panthers among the dogs—a thing they would hardly have done if they had been familiar with house cats. It was not known to the Greeks and Romans till a comparatively late period; and all the earlier representations of cats on their monuments are referred by the authorities to the wild cat or some other animal than the domestic cat. According to the most careful conclusions on this subject, the mouser of the Greeks and Romans was a weasel, and led an independent, not a domestic, life. The Aryans of India had cats at a very early but not at their earliest period; for while the names of the animal are all Aryan, it was not, according to Pictet, designated by any simple term such as would have been given it in primitive times, but by composite names, having such meanings as "house-animal," "rat-eater," and "mouse-enemy." The name of the wild cat (Fig. 2), however, embodied a root common to many of the European languages. It becomes in Persian, *pushak;* in Afghan, *pishīk;* in Kurdish, *psiq;* in Lithuanian, *pnijé;* in Irish, *pus* and *feisag;* and in Erse, *pusag* and *piseag;* whence the English "puss." It is derived by Pictet from a Sanskrit root *puchha* or *pitchha*, that means "tail," and therefore points to one of the most striking external features of the animal. The name by which the cat was known to the later Greeks—αἴλουρος—and which was originally applied to the weasel, refers to the same feature. It is

compounded from two words that give the meaning of "wavy-tail."

The Latin name of the cat tribe (*Felis*) appears to have been originally applied to the weasel and other mousers, and afterward to the wild cat. The word *catus* or *cattus* came into use in about the fourth century, and is found first in the agricultural writer, Palladius, who recommends that cats be kept in artichoke-gardens for protection against mice and moles, and remarks that men had previously been served for this purpose by weasels. The name *catta* is found later in the Greek church historian, Evagrius Scholasticus, about A. D. 594. Historical inferences have been drawn from the absence of the remains of cats in the ruins of Pompeii, and from the fact that the name common to all the other Romance languages does not occur in Wallachian. It is concluded that the domesticated animal had not become common when Pompeii was destroyed, in A. D. 79, or when Dacia was isolated from the rest of the Roman world by barbarian conquest, in the third century. Mr. W. Boyd Dawkins infers, from his researches in the caves in which the Celts took refuge from the Saxons, that cats were unknown in Great Britain before about the year 800.

FIG. 2.—WILD CAT (*Felis catus.*)

Cats easily commended themselves as efficient vermin-destroyers to such extensive grain-raisers as the ancient Egyptians; and a people so ready to deify everything needed little prompting to put them in their pantheon. They may also have made themselves useful in killing snakes, an occupation in which, if the stories are true, they sometimes become very expert. Rengger, who has written of the mammals of Paraguay, declares that he has more than once seen cats pursue and kill snakes, even rattlesnakes, on the sandy, grassless plains of that land. "With their rare skill," he says, "they would strike the snake with their paw, and at the same time avoid its spring. If the snake coiled itself, they would not attack it directly, but would go round it till it became tired of turning its head after them; then they would strike it another blow, and instantly turn aside. If the snake started to run away, they would seize its tail, as if to play with it. By virtue of these continued attacks they usually destroyed their enemy in less than an hour, but would never eat its flesh."

Cats are represented on some of the Egyptian monuments as accompanying their masters on hunting expeditions. In a wall-

picture on a tomb at Gurneh, a hunter is represented in his boat in the marshes as about to hurl his throw-stick at a covey of birds, while a cat by his side is on the alert to spring upon the game he is expected to bring down. Another picture (Fig. 3) represents the cat seizing a bird. This would involve going into the

FIG. 3.—AN EGYPTIAN FOWLING SCENE. 1. Sportsman using the throw-stick. 2. Keeps the boat steady by holding the stalks of a lotus. 4. A cat seizing the game in the thicket. 5. A decoy bird. 6. Fishes, the emblem of water.

water, an act to which our modern cats usually have a very strong dislike. If the Egyptian cats had the same feelings, they must have come under the discipline of skillful trainers. But there have been fisher cats in modern times. Mr. Ross, in his Book of Cats, tells of one that lived in 1829, which caught fish with great assiduity, and frequently brought them home alive. She taught another cat to fish, and they used to go out together, sometimes taking opposite sides of the river. Another story is quoted by the same author, of a cat at the battery in Plymouth, England, that was in the habit of diving into the sea, bringing up fish, and leaving them in the guard-room for the sailors. She was seven years old, and "as fond of the water as a Newfoundland dog," and hunted regularly along the rocks at the water's edge for her game, "ready to dive for it at a moment's notice." A cat described by Mr. Lawson Tait was a remarkable fisher, and would

FIG. 4.—CATS' TAILS.

wade into a small pond up to her shoulders to catch her game. She was "always fond of dabbling in the water." Mr. Harrison Weir* tells of a cat which used to go into the water up to her shoulders to bring in the fish which her master drew up with the hook, and which stole out the minnows that had been placed, for safe keeping, in a well of cold spring-water.

The domestic cat is not identical with the Egyptian cat, and, therefore, if descended from it, must have undergone modifications in the process. It is not known whether it has interbred with the wild cat; but it is possible that some of the varieties have originated in that way. The marks of difference between the species are very plain. The most obvious one is the shape of the tail (Fig. 2), which in the domestic cat is long, slender, and tapering, while in the wild cat it is shorter, stumpy, and bushy. The fact that no tendency has been observed in either of these

FIG. 5.—MRS. SCOTT'S ENGLISH TABBY "COPPA." First Prize at the Crystal Palace Cat Show, 1886.

forms of tail to revert to the other is in favor of a permanent specific difference. The minor varieties of cats are numerous, but the important ones are not many. A line is drawn between the short-haired and the long-haired varieties. Of the former are the tabbies (Figs. 5 and 10)—brown, blue, or silver; red and spotted tabbies—of various colors, with their delicate stripings, cloudings, or spots; the Chartreuse, blue, or Maltese, which has long, slate-colored fur, and a bushy neck and tail; the Spanish, or tortoise-shell (Fig. 11)—white, black, and reddish-brown, mixed, whose

* Our Cats and all about Them. Boston and New York: Houghton, Mifflin & Co.

closer resemblance than that of the others to the Egyptian cat has suggested that the animal may have come to Europe by way of the Strait of Gibraltar; and the Manx (Fig. 6), a curious variety, says Wood, on account of the entire absence of a tail, the place of which member is only indicated by a rather wide protuberance. "It is by no means a canny animal, for it has an unpleasant, weird-like aspect about it. . . . A Manx cat, with its glowing eyes and its stump of a tail, is a most unearthly-looking beast." The manner in which its peculiarity has been perpetuated has not been accounted for. The long-haired cats include the Persian (Fig. 7), a gray-blue and silky animal, having a tail of great length and covered with hair six inches long, which it carries arched over its back like a squirrel's; and the Angola, a beautiful animal, and knowing it—"gorgeous in its superb clothing of long, silky hair and bushy tail." It is one of the largest of domestic cats, and one of the heartiest eaters. Then there are the Chinese cat, large, with fine, glossy hair and hanging ears; the royal cat of Siam (Fig. 8), clear tawny or buff, with black muzzle, face, ears, and feet, suggesting the figure of a pug dog; black cats, which belong among the tabbies; and white cats, concerning which the belief prevails that if they also have blue eyes they are deaf. This connection has been accepted by Mr. Darwin as an instance of correlated variability, and is explained by Mr. Lawson Tait—the white color or albinism being regarded as a result of arrested development—by the fact of the common origin in the epiblast of the three structures affected—the fur, the iris, and the tympanic membrane.

FIG. 6.—MANX CAT.

The bent of the cat's mind was pleasantly defined a few years ago by a writer in the London Spectator, who said there could be no doubt as to the view Puss took of the philosophy of nature and life. She is quite satisfied that the world and everything in it were made and exist for cats. This appears in all that well-bred and cared-for cats do, and in every accent and tone of their voice. Puss possesses herself with the air of a proprietor of the best place and the best food; expects to be waited upon; demands a share of every dish; and looks upon us as at once her Providence and her servant.

Cats are not demonstrative like dogs, and do not submit to training like the horse. The dog has been credited with unbounded affections, and the horse with almost human sagacity;

but the cat still suffers under the bad character that Buffon—who can not have been acquainted with any reputable specimens of the race—gave her. She is said to be selfish, spiteful, cruel, crafty, treacherous, loving places and not persons, and in every way unworthy of fellowship in the household. J. G. Wood answers these accusations by saying that the cats with which he has been most familiar "have been as docile, tractable, and good-tempered as any dog could be, and displayed an amount of intellectual power which would be equaled by very few dogs, and surpassed by none." To all persons who have given their confidence to Puss and received hers in return, they need no answer.

FIG. 7.—MRS. VALANCE'S PERSIAN, "FLUFFY II." Crystal Palace Cat Show, 1886.

Numerous traits of the sort that make all the world kin appear in the cats—human-like qualities and affections that bring them into sympathy with their masters. Such traits will be made manifest to any one who even partially takes Puss into fellowship; and whoever puts himself on good terms with her will find his association marked by wonderful examples of intelligence and affection, and will be ready to declare that there is no cat like the particular one with which he is dealing. The declaration will be true in a measure, for individuality is one of the most conspicuous traits of the species. A considerable literature has been written in demonstration and illustration of the more pleasing aspects of feline character, on which I have drawn for incidents from works that will be mentioned in course; and more freely from articles on animal intelligence in Nature and the Revue Scientifique, and from a Cat Competition, organized several years ago by the Republican Journal, of Belfast, Maine, in which many contributors gave the stories of their pets. Evidences are afforded in these observations of the habitual exercise by cats, in the ordinary course of their lives, of such qualities as recognition of their friends and attachment to them, capacity to form friend-

ships with men and animals, exercise of self-denial, willingness to do favors or to help, understanding of language, ability to make their wants intelligibly known, humor, foresight, knowledge of right and wrong, the use of means to ends, capacity to adapt means to circumstances, the time-sense, and many other forms of intelligence. Lindsay, in his Mind in the Lower Animals, shows also that they, with other brutes, are liable to mental diseases not unlike those to which the human mind is subject.

Théophile Gautier, remarking on the difficulty of conquering the friendship of a cat, says that "she is a philosophical animal, orderly, quiet, tenacious in her habits, a lover of order and propriety, and one who does not bestow her affections blindly. She will gladly be your friend if you are worthy of it, but not your slave. In her tenderness she regards her own free will, and will not do for you what she judges to be unreasonable; but once she has given herself to you, what absolute confidence, what fidelity of affection!" Wood says that there is perhaps no animal so full of trust as a cat that is kindly treated, as there is none which, when subjected to harshness, is so nervously suspicious. Cats keenly recognize these distinctions in character, even among members of the same family, and govern themselves accordingly. Pertinent to this point is the newspaper squib of the maid who told her master that she knew Tom had returned from school, though she had not seen him, because the cat was hiding under the stove.

FIG. 8.—MRS. VYVYAN'S ROYAL CAT OF SIAM. Prize-winner. By permission, from Harrison Weir's Our Cats and all about Them. Published by Houghton, Mifflin & Co., Boston and New York.

"Tad," of Burnham, Maine, used to meet his master, a night watchman, every morning at the store-door, and accompany him home. After the master died, "Tad" continued to go for him and wait; then, not finding him, would return home and wander about the house as if in search of him. "Hannah," of North Monroe, Maine, began to take care of the baby as soon as it came; increased its attentions when the child could walk; would go after him and call him back when he started to wander out of bounds, and then go to the house and mew for help till some one came to take the truant in charge. "Thomas," of Sandy Point, Maine, was accustomed to be fed with crumbs from the table by a single

member of the family, and to go and call him to dinner if he was tardy. My cat in like manner used to look to her mistress and to no other person for tidbits from the breakfast-table. "Daisy," of Belfast, who stayed with her mistress during an illness, missed her from the room and went out to look for her. Meeting her unexpectedly, she looked up, says the mistress, "as frightened as if she had seen a ghost. My voice, however, reassured her, and, if ever a cat smiled, I am sure she did." Another cat of the Belfast group, not a favorite and shy toward all other persons, became attached to a sickly infant and its faithful nurse, never failing to respond to its cries by going to its cradle and soothing it by purring and caresses till it became quiet. The cat of M. Arbousset, a French missionary in Africa, refused food when the child to which it was attached died, sought and mourned for its friend in a marked manner, and in a few days was found dead on its grave. The suggestion has been made, and is worthy of con-

FIG. 9.—ARCHANGEL BLUE CAT. By permission, from Harrison Weir's Our Cats and all about Them. Published by Houghton, Mifflin & Co., Boston and New York.

sideration, that when pets die in this way soon after their human companions, it may be because they caught the disease from them rather than from intensity of affection. But this can not apply to the cat told of in the Leisure Hour, which, when the child its playmate died, refused food at first, but afterward, having found its companion's grave, spent most of its time there, going to the house for its meals. A critic, in the Saturday Review, claims to have known more than one instance of a cat, ordinarily constant to its own habits of comfort, breaking through its self-made rules to sit outside the door of an invalid as if waiting for news. The Rev. J. G. Wood's "Pret" was capable of the most earnest manifestations of gratitude. One day, when, having been forgotten, she had become very hungry, she flew "like a mad thing" at the meat and milk her master gave her; but hardly lapped a drop before she went to him purring loudly and caressing him to express her thanks; then went to the plate, "but only just touched

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her nose, and again came to thank me"—actually refraining from enjoying the food she was so much in want of till she had repeatedly acknowledged her obligations for it.

A story is quoted by Mrs. Cashel Hoey from the London Spectator, of "Nero," who, loving all the family and showing his love for each in different ways, especially loved his master, and was usually the first to hear his step. He could distinguish the click of his master's door-key, and would run to answer it; was distressed if his master failed to return at evening, and would go look for his portmanteau, to see if that was gone too—that being his sign that master was taking a journey. If the portmanteau was in its place, he was satisfied; if not, he would lie down and refuse food. If he knew the master was going away, he would try to hide himself in the cab; and if master appeared with his hat on in the daytime, supposing he was going out, would try to take it off; but if at night, was contented, for master had come home.

FIG. 10.—FINELY MARKED SPOTTED TABBY CAT. By permission, from Harrison Weir's Our Cats and all about Them. Published by Houghton, Mifflin & Co., Boston and New York.

The cat's strong attachment to its home, and indisposition to change it, are not peculiar to it, but are common to all animals, including man. The trait is often manifested, and sometimes in remarkable ways, in dogs, horses, and cattle. In man it is frequently illustrated in the affection known as "homesickness." The ability which animals display under its influence in finding their way back to their old accustomed haunts from long distances and by difficult or tortuous ways, or even by roundabout roads, when return over the direct route (as when it includes the crossing of bodies of water) is impossible, is the wonder of naturalists, and up to this time one of the unsolved

problems of animal psychology. It has received the name of "the homing instinct," and is regarded by some naturalists as constituting an additional sense. The dog seems usually to be more ready than the cat to follow his master in a change of home, and to reconcile himself to the new place, but this may be because he stands in a different relation toward him. The dog is sure of at least one fast friend wherever he lives, while the cat can not always reckon even upon that. In many families, where she is tolerated, as, according to Buffon, only because she is less objectionable than the rats and mice, she has no one to caress her or show affection to her. In this case, when her situation is barely endurable, she naturally fixes her attachment on the place where she has found cozy retreats and knows all the hunting-grounds, rather than upon persons who have given her no consideration, and of whom she perhaps stands in fear. Whether the cat will in the long run prefer its old home, deserted or inhabited by strangers, to a new home, along with the persons it has been accustomed to meet, may depend very much upon the treatment it has received from those persons. My cat was removed three times in ten years; and, aside from the temporary embarrassment caused by finding herself in a strange place, readily adapted herself to the new quarters, and showed no disposition to go back to the old haunts. Lindsay, in

FIG. 11.—FINELY MARKED TORTOISE-SHELL CAT. By permission, from Harrison Weir's Our Cats and all about Them. Published by Houghton, Mifflin & Co., Boston and New York.

his Mind in the Lower Animals, refers to cases of cats following their masters from house to house, from place to place, and accompanying them on visits to other people's residences, as unconcernedly as a dog. Wood tells of a family on the coast of Scotland who removed to the opposite shore—sailing around instead of crossing the country—leaving their cat with a neighbor. But the animal followed them, and found them in some way, presenting itself after a few weeks at their door, "weary, ragged, and half starved." It had left its old home and gone out into the unknown to seek the family with whom it had lived. A case pre-

cisely similar, except as to the local topography, is related in Chambers's Journal, of a cat in a military chaplain's family at Madras. This animal also, having found its old friends on the other side of the city, several miles from their former home, went back and brought her kitten. Some of the incidents bearing upon this feature have an aspect of eccentricity. The young cat of a neighbor of the writer's disappeared from the house and was not found or heard of for six months. At the end of that time it returned and made itself at home at once, but grown and so changed that, though its familiarity was remarked upon as singular, it was not recognized till its identity was accidentally established by the discovery of a peculiar though obscure mark. Dr. A. Corriveau tells in the Revue Scientifique of a cat which was lost in a similar way. Five months afterward it was found in the house by the side of its companion, travel-soiled but plump, and recognizable by a red spot on its forehead. It had a very pleasant visit with its old mate and friends for a week, and then disappeared as unaccountably as it had done before. It is told in the Life of Sir David Brewster, by his daughter, that a cat in the house entered his room one day and made his friendship in the most affectionate manner—"looked straight at him, jumped on his knee, put a paw on each shoulder, and kissed him as distinctly as a cat could." From that time the philosopher himself provided her breakfast every morning from his own plate, till "one day she disappeared, to the unbounded sorrow of her master. Nothing was heard of her for nearly two years, when Pussy walked into the house, neither hungry nor thirsty nor foot-sore—made her way without hesitation to the study—jumped on my father's knee—placed a paw on each shoulder—and kissed him exactly as on the first day."

These incidents pertain to only one of the human-like traits that have been named as to be found in cats. The study to which they introduce us is an alluring one, and opens the more expansively the further we proceed in it.

PROF. MENDELEJEFF, in his Royal Institution lecture, found an analogy between the unseen world of chemical changes and the visible world of the heavenly bodies. Our atoms, he said, form distinct portions of an invisible world, as planets, satellites, and comets form distinct portions of the astronomer's universe; "our atoms may therefore be compared to the solar system, or to the systems of double or of single stars; for example, ammonia may be represented in the simplest manner by supposing the sun nitrogen, surrounded by its planets of hydrogen, and common salt may be looked upon as a double star formed of sodium and chlorine. Besides, now that the indestructibility of the elements has been acknowledged, chemical changes can not otherwise be explained than as changes of motion; and the production by chemical reactions of galvanic currents, of light, of heat, of pressure, or of steam-power, demonstrates visibly that the processes of chemical reaction are inevitably connected with enormous though unseen displacements, originating in the movements of atoms in molecules."

RECENT GLACIAL WORK IN EUROPE.

By Mrs. K. B. CLAYPOLE.

AT the recent meeting of the British Association at Newcastle, Prof. James Geikie opened the Section of Geology with a summary of the results obtained during the last few years by continental glacialists. Sketching the steps by which the iceberg theory has been abandoned by German and Swiss geologists, he dwelt on certain features of the drifts of the peripheral areas, which for some time were hard to account for by land-ice. Of these, the bedded deposits occurring so frequently in the bowlder-clays of the peripheral regions, and the occasional silty and uncompressed character of the clays themselves, remained unexplained until a clew was found to their origin in the geographical distribution of the clays in which they occur. These stony clays, of inconsiderable thickness in Norway, the higher parts of Sweden, and in Finland, reach a thickness of about forty-three metres in southern Sweden, and eighty metres in the northern parts of Prussia; and in Holstein attain a depth of one hundred and twenty to one hundred and forty metres, and still greater depths in Hanover, Mark Brandenburg, and Saxony. The aqueous deposits associated with the stony clays also gradually acquire more importance as they are followed from the mountainous and high-lying tracts to the low ground, until, along the southern margin of the drift area, the "diluvium" appears to consist of aqueous accumulations alone. The explanations of these facts by German geologists have been summed up recently (1884) by Dr. Jentzsch, from whom Prof. Geikie quoted enough to show that they are quite in accordance with the views long held by glacialists elsewhere.

The general conclusions reached by continental glacialists, and summarized by Prof. Geikie, are:

1. Before the invasion of northern Germany by the inland ice, the low grounds bordering on the Baltic were overflowed by a sea which contained a boreal and arctic fauna.

2. The next geological horizon in ascending order is that which is marked by the glacial and fluvio-glacial detritus of the great ice-sheet which flowed to the foot of the Harz Mountains, and has been traced by the occasional presence of rock-striæ and *roches-moutonnées*, of bowlder-clay and northern erratics, rather than by recognizable terminal moraines.

3. A well-marked temperate fauna and flora marks the interglacial beds which follow, and which, in their geographical distribution and the presence in them of such forms as *Elephas antiquus*, *Cervus elephas*, and *C. megaceros*, and a flora compar-

able to that now existing in northern Germany, justify geologists in concluding that this era was one of long duration, and characterized in Germany by climatic conditions apparently not less temperate than those that now obtain.

4. To this well-marked interglacial era succeeded a second overflow of Scandinavian inland ice, confined to a region much narrower than that covered by the first. Its boundaries are shown not only by the geographical distribution of the youngest bowlder-clay, but by the direction of rock-striæ, the trend of erratics, and the position of well-marked moraines.

Concerning the ground-moraines of the Alpine lands of central Europe, the only question that has recently given rise to much discussion is the origin of the materials themselves. The observations of able investigators appear to Prof. Geikie to have demonstrated that these materials have been derived, in chief measure, from the underlying rocks by the erosive action of the ice that overflowed them. German geologists are not agreed upon this much-debated question of glacier-erosion—a few still maintaining that glaciers have little or no eroding power. But where the evidences of erosion have been studied over a wide region, from which the ice has completely disappeared, rather than at the lower ends of existing glaciers, some of the strongest opponents of glacier-erosion have been compelled to go over to the other camp. As an example, Prof. Geikie quoted Dr. Blaas, who, through his observations on the glacial formations of the Inn Valley, has recanted his former views and become a formidable opponent of the very theory which he once upheld. To his books and to memoirs by Penck, Brückner, and Böhn, and especially to the chapter on glacier-erosion by the last-named author, Prof. Geikie refers those who may be anxious to know the last word on this question.

Observations by Drs. Brückner and Penck have led to the opinion that the loess is of interglacial age. Examining a wider range of evidence, Prof. Geikie has little doubt that the loess belongs to no particular horizon, though it must be considered strictly a Pleistocene accumulation. Concerning its mode of formation he discussed the various theories advanced, and gave it as his opinion—an opinion formed from what he has himself seen of the loess in various parts of Germany, from reading, and from conversation with those who have worked over loess-covered regions—that it is for the most part of aqueous origin, formed in the slack waters of the great rivers, and in the innumerable temporary lakes which occupied or partly occupied many of the valleys and depressions of the land. Probably some may have been derived from the denudation of bowlder-clay, some from "rain-wash," while much of the so-called Bergloess with its abundant

land-shells, and its generally unstratified character, owes its origin to rain, frost, and wind. Admitting that some of the loess of the lower grounds may have been reworked by the same agents, Prof. Geikie found no evidence in the facts adduced by German geologists of a "dry-as-dust" epoch having obtained in Europe during any stage of the Pleistocene period.

Within recent years the fossils of the loess have received close attention, and through them so much knowledge has been gained of the various modifications experienced by Pleistocene organisms that, taken with other evidence of interglacial conditions, there is little room to doubt that this period was characterized by great changes of climate. How often arctic, steppe, prairie, and forest faunas and floras have replaced each other is yet a matter of dispute. The occurrence of fossiliferous deposits intercalated among glacial accumulations throughout all the glaciated tracts of Europe show that however many advances and retreats of the ice there may have been, they were on a gigantic scale characterizing all the glaciated areas.

The bearing of the establishment of at least two eras of glaciation on the position of Palæolithic man was pointed out by Prof. Geikie. The mere occurrence of glacial deposits underneath implement-bearing beds no longer proves these latter to be post-glacial. The horizon of glacial accumulations underlying Palæolithic gravels must now be determined by ascertaining their relative position; and it is a remarkable fact that the bowlder-clays which occur beneath such old alluvia belong, without exception, to the earlier stages of the Glacial period. In 1871–'72 Prof. Geikie published a series of papers in the Geological Magazine, maintaining that the alluvial and cave deposits must be assigned to preglacial and interglacial times, and in chief to the latter. Evidence was adduced to show that during the last stage of the Glacial period man lived contemporaneously with a northern and Alpine fauna, in such regions as southern France; and that Palæolithic man and the southern mammalia never revisited northwestern Europe after extreme glacial conditions had disappeared. Prof. Geikie at the same time colored a map to show at once the areas covered by the glacial and fluvio-glacial deposits of the last Glacial era, and the districts in which the implement-bearing and ossiferous alluvia had been found; and this clearly brought out that the latter never occurred at the surface within the regions occupied by the former. Similar evidence has been recently obtained by continental geologists; and a map published by Dr. Penck in 1884, showing the areas covered by the earlier and later glacial deposits in northern Europe and the Alpine lands, and indicating at the same time the various localities where Palæolithic finds have occurred, does not give a single

locality within the regions covered by the accumulations of the last Glacial era. So greatly are students of the Pleistocene ossiferous beds influenced by what is known of the interglacial deposits and their organic remains, that many do not now hesitate to correlate with those beds the old ossiferous and implement-bearing alluvia which lie altogether outside of glaciated regions. In France, where the relation of Pleistocene alluvia has been especially canvassed, these alluvia have been also included among interglacial deposits. M. Boule also, in the Revue d'Anthropologie, 1889, correlates the Palæolithic cave and river deposits of France with those of other countries, and shows that they must be of interglacial age. He is satisfied that in France there is evidence of three glacial and two well-marked interglacial eras. The oldest of the Palæolithic stages of Mortillet culminated during the last interglacial era, while the more recent Palæolithic stages coincided with the last great development of glacier ice. The Palæolithic age, so far as Europe is concerned, came to a close during this last cold phase of the Glacial period.

Interesting as is the development of the climatic and geographical changes of which our Palæolithic predecessors were the witnesses, the clearing up of the history of Pleistocene times is not the only end that workers in this field have in view. Prof. Geikie, therefore, closed his address with a hope that the definite knowledge of the conditions of the Pleistocene period and of the causes which gave rise to them would lead to the better understanding of the climatic conditions of still earlier ages; the success with which other problems have been attacked by geologists forbidding him to doubt that ere long we shall have done much to dispel some of the mystery still enveloping the question of geological climates.

THE BOTANIC GARDENS AT KEW.

By FREDERIK A. FERNALD.

IT is now about two hundred years—the exact date is not known—since Lord Capel laid out the garden that has become a scientific institution of world-wide fame and influence. Switzer says, in his quaint Ichnographia Rustica, 1718, "The earliness with which this lord appeared in gardening merits a very great place in my history, and a better pen than mine to draw it." On the death of Lord Capel, in 1696, the estate of Kew House, including the garden, passed into the hands of his son-in-law, who added to its importance for a while by making it the headquarters of English astronomy. It was afterward leased by Frederick, Prince of Wales, son of George II. The garden was made a scientific es-

tablishment—what they called a "Physic Garden" in those days—by the widow of Frederick, the dowager Princess Augusta, under the advice of the Earl of Bute. She employed William Aiton to direct the scientific work, and Sir William Chambers to superintend the decorative gardening. "Science will ever be grateful to the one," says a writer in The Saturday Review,* "and Taste will never forgive the other while his constructions remain." In 1768 Sir John Hill published a catalogue of the plants at Kew. There were fifty ferns, about six hundred trees and shrubs, and several thousands of herbaceous plants. The list was not greatly lengthened twenty-one years after, when Aiton issued the Hortus Kewensis with the aid of Dr. Solander. But the collections made by Sir Joseph Banks in Captain Cook's famous voyage were deposited here; then those of Robert Brown and Allan Cunningham, who had accompanied Captains Flinders and King respectively to Australia; then the plants of Brazil and the Cape of Good Hope, gathered by Messrs. Bowie and Masson; those of Caley, and Ker, and Menzies, and a host of smaller collections. In 1810 William Aiton the younger published a new edition of his father's work, which contained nearly ten thousand descriptions. About 1789 the estate was bought by George III, who devoted much of his leisure to its improvement. But evil days followed the death of Sir Joseph Banks, in whom Kew had a friend at court. For all Aiton could do, the gardens sank into neglect, and in 1838 it was proposed to disestablish and disendow them. A protest was raised, and, after further consideration, the gardens were surrendered by the crown and became a national establishment in 1840. Sir W. J. Hooker was appointed director in the following year. Kew has been fortunate in having had few changes in directors. It was in charge of William Aiton from 1759 to 1793; of William Aiton, Jr., from 1793 to 1840; Sir W. J. Hooker was director from 1841 to 1866; his son, Sir Joseph D. Hooker, from 1866 to 1886; and to him has succeeded Mr. W. T. Thiselton Dyer.

Under the directorship of Sir W. J. Hooker the Royal Botanic Gardens rapidly advanced in importance. During his term of office a report of the Progress and Condition of the gardens was made annually. This was superseded in 1883 by a monthly Bulletin of Miscellaneous Information. The early reports of Sir William Hooker are interesting, besides their historic and scientific value, for the evidence they give of his sturdy, ceaseless battles with the Treasury. The director is pathetic, indignant, and argumentative by turns, and one way or another he contrived to

* The writer is indebted to an appreciative article in The Saturday Review (London), of October 5, 12, and 19, 1889, for the material of this sketch.

worry on till better times. In 1844 Sir William took the first important step of his administration by petitioning for a grant of the Royal Fruit House, which he offered to fill with his private collection of plant products. It was allowed in 1847, and thus the Museum of Economic Botany had its origin. This branch of the establishment now occupies three buildings. Every tree and plant which is known to serve a useful purpose is represented there, with illustrations of the manner of its employment, if possible. While the collection is very popular with the holiday visitor who comes only to be entertained, any one can understand its serious value to an ingenious and thoughtful mechanic or manufacturer. The Museum of Timber is largely used already. Cabinet-makers and furniture manufacturers quite recognize by this time what a store of hints for their craft is garnered here. The utility of the economic section, moreover, is by no means confined to the inhabitants of the British Isles. From every quarter of the globe samples of new products are sent for examination and report.

So long ago as 1815 an Herbarium and Botanical Library had been projected at Kew. George III, doubtless persuaded by Sir Joseph Banks, even raised a building for the purpose. After Sir Joseph's death, however, the scheme lapsed, and the building was granted to the King of Hanover. On his decease, Sir William Hooker urged the fulfillment of the old design, and his petition was granted when Mr. Bentham and Dr. Bromfield bequeathed their collections to the nation. The Herbarium of Kew is the largest in the world, and by far the most useful, because it is also most admirably arranged. The number of specimens in it is not on record. At Sir William Hooker's death, twenty-four years ago a rough estimate made the number a million, exclusive of duplicates. The written catalogue fills two gigantic volumes, and has to be continually posted up, for the collection increases by twenty thousand or so yearly. The dried plants in their portfolios stand in cases, and all are arranged upon the system of Sir Joseph Hooker's great work, the Genera Plantarum. The student has only to give the number attached to any genus in that book, and the case is unlocked and the portfolio laid before him in a moment. There are no formalities to check the young scholar here. He has but to present his credentials to Prof. Oliver, keeper of the herbarium, sign his name, and get to work. There are interesting features at every step of this noble collection, fascinating bits of history connected with every group of cases which bears the name of some distinguished botanist, the fruits of whose life-long labor are stored here. Of all these, perhaps the herbarium of Dr. Lindley is the most attractive. It occupies only four small cabinets, but the contents will surpass the visitor's utmost expectations. On the lower floor is preparing the catalogue of all plants

known, for which Mr. Darwin left a bequest. Mr. Daydon Jackson, Secretary to the Linnæan Society, has had the work in hand over three years, and it is not nearly finished. He employs a staff at the British Museum also. The catalogue of the library is not printed, but is contained in a ponderous manuscript volume in the keeper's room. The books include, besides all modern volumes and pamphlets on botany, a great number of those antique curiosities which bibliomaniacs treasure.

The work at Kew covers a vast field. In the first place officially stand the botanic interests—to study new plants and class them. Next, where plants are wanted for cultivation, which can not be obtained readily in the market, or which the service of the public demands, the Royal Gardens will supply them if possible. Where diseases, vegetable or animal or insect pests, threaten local plantations, Kew will look into the matter and consult with experts at home. Kew is ready also to report and to obtain advice upon new-industries which those upon the spot suggest. Furthermore, it keeps an eye on all institutions of the same class throughout the British Empire, which act in concert with their great model in the mother-country, and through it with one another. Foreign institutions co-operate in like manner with Kew to a certain extent. From time to time the authorities of Kew publish a list of new plants, which at present seem to average five hundred to six hundred a quarter, including those renamed for scientific purposes. From time to time, also, they publish a list of the seeds matured in the Royal Gardens, which are exchanged, on application, with all regular correspondents. One of these seed-lists includes something like four thousand species. This magazine of seeds is collected, nominally, for the benefit of institutions which may be able some time to return the favor in part, but in practice no one who applies with a serious purpose for seeds or plants is refused. How the rapidly increasing population of the globe is to be provided with food and clothing is a problem which the authorities of Kew believe falls within their department. They welcome every vegetable product which is reported to have qualities that make it useful to mankind, whether as a food, a medicine, a convenience, or a substance useful in manufactures. They are glad to report upon specimens of such substances, or to obtain the reports of trustworthy experts.

The story of the cinchona plantations is a good instance of the work of the Royal Gardens. Some forty years ago both the English and the Dutch authorities in the East Indies took alarm at the growing price of quinine, due to the rapid decrease of the forests of cinchona in Peru. The Dutch moved first, and imported a great number of seeds and seedlings, which they planted in Java at a heavy cost. But, probably because they had no Kew to advise

them, the Dutch had chosen a species which was hardly worth growing, and the plantations have been long since uprooted. For some years the English Government confined itself to importing seeds and plants, which died on the passage to India. This was evidently futile, and Sir William Hooker urged a systematic procedure. Mr. Clements Markham, in 1859, was sent to Peru to collect seeds and young trees. When he returned, his precious stores were received at the Gardens, nursed, and transmitted to India with trifling loss. This effort was successful. In the plantations of Bengal, laid out and managed by officers recommended by Sir William Hooker, there were, at the date of the latest report, about five million trees. From Kew cinchona-trees have been distributed also to all parts of the world where there was a chance for successful cultivation. The plantations of Ceylon are only inferior to those of Bengal; in Jamaica the sales of bark exceed £5,000 a year; the tree has been introduced also into St. Helena, Trinidad, Mauritius, Cape of Good Hope, Queensland, and many other settlements. The output of the cinchona drugs from these sources up to 1880 was 87,704 pounds, which, taking quinine at an average value of two dollars an ounce, would represent $2,806,528.

Ipecacuanha is a plant scarcely less important than cinchona itself. But few members of the vegetable kingdom so absolutely refuse to exist under anything short of perfectly satisfactory conditions. In 1866 Sir Joseph Hooker sent a specimen to the Botanical Gardens at Calcutta, which promptly died. Then a struggle began in which the advantage was now on one side, then on the other. In 1875 the Director of the Calcutta Gardens triumphantly reported that he had one hundred thousand nice young plants, but in 1886 the strain received from Kew direct alone survived—less than five per cent—and all hope of successful cultivation in India has been abandoned long since. Plants had been sent out to Singapore, however, in 1875, with much more lively confidence, and there perseverance found its reward. Ipecacuanha is established in the Old World at last, and the authorities of Kew may be trusted to diffuse the cultivation. Another instance is Liberian coffee, distributed from Kew to take the place of that grown in the East Indies, which was affected by a fungoid pest, and that of the West Indies, which suffered from the white fly. Liberian coffee, moreover, will thrive in hot and moist situations, where the Arabian variety is unable even to live. It has been introduced in a great many places, but, although its growth is very promising, it has nowhere become the general crop. This imperfect success was another problem for the investigators of Kew, and the solution is now believed to be found in the fact that the treatment proper for the Arabian berry after gathering is not suited to the Liberian, with a widely different pulp.

Among the many questions sent to Kew from all parts of the world, there must be some of trivial importance, or which could be perfectly well answered at the local botanic gardens. But all genuine inquiries receive attention. Debate has been gravely held, opinions even have been formed and reported upon such matters as a South African cane which some gentleman in those distant parts thought adapted for fishing-rods; upon the value of West African palm-kernels as material for coat-buttons; upon a pithy stem which the government of a West India island believed suitable for razor-strops.

One function of a national institution very seriously regarded at Kew is the training of young men to fill botanic situations in the colonies. Something is demanded of such young men beyond the practical knowledge which suffices at home. Instruction is given them in the principles of scientific botany, and those general conditions which rule the practice of horticulture under differing circumstances. The advantage of this system all around scarcely needs illustration. While serving the interest of the colonies, it increases the sources of information for Kew, since all these emigrants keep up more or less of a correspondence with the institution in which they were trained.

The village of Kew lies on the south side of the Thames, about six miles westward from Hyde Park Corner in London. "The Gardens" are a favorite resort for holiday-makers and tourists, being visited by six or seven hundred thousand persons yearly. Painters also flock there in summer-time. When the crown surrendered its rights to them in 1840, the Gardens had an area of eleven acres, and contained ten greenhouses of one sort or another. Sir William Hooker promptly begged permission to annex the Orangery and the land adjacent; then a part of the Pleasure Grounds; and after that the Royal Kitchen and Forcing Grounds. All these petitions being granted, by 1847 the Gardens had reached their present dimensions—about seventy acres. Three years later the rest of the Pleasure Grounds was granted for the establishment of an Arboretum, making the total area little less than two hundred and fifty acres. "The Arboretum is the richest in Europe, no doubt," says the writer in The Saturday Review, "but probably inferior to that of Harvard University, where special attention has been paid to this department." This admission in a British journal, and The Saturday Review above all others, should be very gratifying to Americans. The failure of Kew's Arboretum to be the finest in the world is explained on the ground that the soil—sandy and shallow, resting on a stratum of gravel—is unsuited to many kinds of trees. In former times, also, when an imperial collection had to be got together as quickly as possible, and as cheaply, specimens

were not planted with the care which might have overcome the disadvantage. It became necessary to reconstruct the Arboretum twenty years ago on this account. A singular example of the influence of fashion in gardening then came to light. The British public had been running after evergreens so hotly that nurserymen had ceased to grow deciduous species. It seems incredible that the authorities of Kew should have asked in vain for months throughout England, Scotland, and Ireland, for young aspens. As for American oaks, maples, etc., they absolutely could not be found in the kingdom. Unscientific lovers of the beautiful may rejoice that it has not yet been found necessary to interfere with the old forest trees, planted, perhaps, by Lord Capel. The new-comers are arranged by genus—all the willows, for example, with the alders, around the pretty lake, pines here, cedars there, oaks, nuts, maples, tamarisks, camellias, ranunculus, etc., etc.

In the Garden proper the smaller plants are found in bewildering array. No list of the species represented at Kew has been taken since that of the younger Aiton in 1810, but one is now being made. Some departments have been catalogued already. Of orchids, there are about 1,400 species; ferns, 1,100; stove plants, 2,500; succulents, 1,000; palms and cycads, 500; greenhouse plants, 3,000; herbaceous, 4,000; trees and shrubs, 3,000; in several cases, however, the figure is but a guess as yet. The total, great as it will prove to be, bears but a small proportion to the sum of Nature's wealth. If we take the flowering plants alone, as enumerated in Bentham and Hooker's Genera Plantarum, there are two hundred natural orders, 10,000 genera, and 100,000 species; and this leaves out of account the ferns and all the lower orders of *Cryptogamia*. The Economic Section has few visitors, and they are not tempted to carry exploration far. Not a few of the culinary and medicinal herbs in use are found here. If by some fatal chance the onion of commerce should be exterminated in the back-gardens of England, Kew is prepared to replace it. Side by side therewith grow the patience-dock and the skunk-cabbage, the briony, the cuckoo-pint, the Japanese yam, and the all-good. In ferns the Kew collection is exceedingly rich. It has had three special benefactors in this department, to the first of whom, Mr. George C. Joad, the public is indebted for the charming rock-garden opened in 1881. Sir Joseph Hooker had long been working for one, and the bequest of Mr. Joad's collection of ferns brought the matter to a crisis. Dr. Cooper Forster was an enthusiast upon the culture of filmy ferns, and Mr. W. C. Carbonell was specially interested in the cultivation of hardy ferns, particularly in the crossing of them, and the development of sports. Both these gentlemen bequeathed their treasures for the nation's enjoyment when their own power of enjoying them ended.

The glass houses at Kew are extensive structures. The Winter Garden covers more than an acre and a half of ground. The Palm House is three hundred and sixty-two feet long and one hundred feet wide. The new Orchid House is one hundred and forty feet in length, adding the two wings together. This last is not wholly satisfactory—to the orchid enthusiast an orchid house never is, nor can be. Supplemented, however, by a low, neat range, from which the public is excluded, nearly all the 1,400 species which form the national collection thrive admirably. British orchidists are proud of Kew—nowadays—for it was not so satisfactory in this department a few years since.

SKETCH OF HENRY R. SCHOOLCRAFT.

MR. SCHOOLCRAFT was a conspicuous figure in the scientific life of the early part of the century. A pioneer in some fields, the immediate follower of the pioneers in others, he was, in all the branches of research to which he gave attention, earnest, ready, diligent, sagacious, original, and modest. As among his titles to be remembered, the biographer who prefaces his Personal Memoirs names the early period at which he entered the field of observation in the United States as a naturalist; the enterprise he manifested in exploring the geography and geology of the Great West; and his subsequent researches as an ethnologist in investigating the Indian languages and history. "To him we are indebted for our first accounts of the geological constitution and the mineral wealth and resources of the great valley beyond the Alleghanies, and he is the discoverer of the actual source of the Mississippi River in Itasca Lake. For many years, beginning with 1817, he stirred up a zeal for natural history from one end of the land to the other, and, after his settlement in the West, he was a point of approach for correspondents"—on these topics and for all the Indian tribes.

HENRY ROWE SCHOOLCRAFT was born in Albany County, N. Y., March 28, 1793, and died in Washington, D. C., December 10, 1864. He was the descendant, in the third generation, of an Englishman, James Calcraft, who, having served with credit in the armies of the Duke of Marlborough, came to America in the reign of George II, in the military service, and was present at operations connected with the building of Forts Anne, Edward, and William Henry. After these campaigns he settled in Albany County as a land-surveyor, married, and in his old age conducted a large school—the first English school that was taught in that frontier region. In connection with this incident his name became

changed to Schoolcraft. He died at the age of one hundred and two years. John, his third son, was a soldier under Sir William Johnson. Lawrence, John's son, distinguished himself during the siege of Fort Stanwix. He was afterward director of the glass-works of the Hon. Jeremiah Van Rensselaer, at Hamilton, near Albany; and established the manufacture of glass in western New York.

Henry Schoolcraft spent his childhood and youth in Hamilton, cultivated poetry, and maintained an excellent standing in scholarship. At an early age he manifested a taste for mineralogy and natural science, which were then (about 1808) almost unknown in the country; formed the beginnings of collections; and organized an association for mental improvement. He investigated the drift stratum of Albany County as seen in the bed of Norman's Kill; and afterward, while living at Lake Dunmore, Vt., put himself under the teaching of Prof. Hall, of Middlebury College; added chemistry, natural philosophy, and medicine to his studies; erected a chemical furnace, and went into experimenting; and picked up a knowledge of Hebrew, German, and French. He began writing for books and periodicals in 1808—contributing, among other things, papers on the Burning Springs of western New York, and on archæological discoveries that had been made in Hamburg, Erie County. In the last paper, which was published at Utica in 1817, he pointed out the necessity of discriminating between the antique French and European, and the aboriginal period, in American antiquity. He was engaged for a time in directing the building of works connected with his father's glass-making enterprises in Vermont, New Hampshire, and western New York. The ideas and knowledge gained in these operations supplied the material for his proposed work on Vitreology, or the application of chemistry to glass-making, the publication of which was begun in 1817. The supervision of these works required the making of considerable journeys, and these created in him the desire to travel through the wilds of the "Far West," which then hardly extended beyond the Missouri River.

He made some "preliminary explorations" to his contemplated journey in western New York in 1816 and 1817, and started from Olean on the Alleghany River for a journey down the Ohio and up the Mississippi in 1818. A large company of intending emigrants had gathered there waiting for the season to open, and Schoolcraft took passage in the first ark. Arrived at Pittsburg, he stopped to explore the geology of the Monongahela Valley, and was greatly interested in the rich coal and iron beds. He stopped to visit the Grave Creek mound and the ancient works at Marietta. At Louisville he found "organic remains" of several spe-

cies in the limestone rocks of the falls, and published anonymously in the paper some notices of its mineralogy. At the mouth of the Cumberland River he exchanged the ark for a keel-boat or barge, with which, propelled by poles pushing on the bottom, he made from three to ten miles a day against the swift current of the Mississippi to Herculaneum, Mo. On this voyage he traveled over a large part of the west bank on foot, and gleaned several facts in its mineralogy and geology which made it an initial point in his future observations. He spent three months in examining the lead mines, personally visiting every mine or digging of consequence in the Missouri country and tracing its geological relations into Arkansas. Hearing of syenite suitable for millstones on the St. Francis, he visited that stream and discovered the primitive tract; and he pushed his examinations west beyond the line of settlement into the Ozark Mountains. He now determined to call the attention of the Government to the importance of its taking care of its domain in the mines, and with this purpose packed his collections and took passage in the new steamer St. Louis for New Orleans. Hence, having inquired into the formation of the delta of the Mississippi, he sailed by brig for New York. He opened his collections and invited examination of them, published a book on the mines and physical geography of the West and a letter on its resources, and went to Washington to present his views on the care of the mines to the officers of the Government. While he was looking for a secretary within whose purview the matter fell, Mr. Calhoun invited him to accompany General Cass, Governor of Michigan, as naturalist and mineralogist on an expedition to explore the sources of the Mississippi and to inquire into the supposed value of the Lake Superior copper mines. He accepted the position, though the compensation was small, because, he says, "it seemed to be the bottom step of a ladder which I ought to climb."

Mr. Schoolcraft left New York in March, 1820, reached Niagara Falls on the 1st of May, and Detroit by steamer a week later. While waiting for the completion of arrangements for embarkation, he attended to the correspondence which had been provoked by the publication of his work on the mines and the resultant awakening of interest in the varied resources of the Mississippi Valley and the subject of geographical and geological explorations. He determined to reply to all letters that appeared to be honest inquiries for geographical facts, "which I only, and not books, could communicate." The route of the expedition "lay up the Detroit and St. Clair Rivers and around the southern shores of Lakes Huron and Superior to Fond du Lac, thence up the St. Louis River in its rugged passage through the Cabotian Mountains to the Savannah summit which divides the Great Lakes

from the Mississippi Valley. The latter was entered through the Cantaguma or Sandy Lake River. From this point the source of the Mississippi was sought up rapids and falls and through lakes and savannahs, in which the channel winds. We passed the inlet of Leech Lake, which was fixed upon by Lieutenant Pike as its probable source, and traced it through Little Lake Winnipeg to the inlet of Turtle Lake in upper Red Cedar or Cass Lake in latitude 47°. On reaching this point the waters were found unfavorable to proceeding higher. The river was then descended to the falls of St. Anthony, St. Peter's, and Prairie du Chien. From the latter point we ascended the Wisconsin to the portage into Fox River, and descended the latter to Green Bay." At this point the expedition was divided. The party to which Mr. Schoolcraft was attached proceeded to Chicago, thence traced the eastern coast of Michigan, and rejoined the other party, which had gone north to trace the shores to Michilimackinack. About four thousand miles were traversed. Reports were made to the Government by Mr. Schoolcraft on the mineralogy and geology of the region; on the copper deposits of Lake Superior; on the botany, fresh-water conchology, zoölogy, and ichthyology; soil, productions, and climate received attention; and the Indian tribes were subjects of observation by General Cass. "In short, no exploration had before been made which so completely revealed the features and physical geography of so large a portion of the public domain." A new interest in mineralogy and geology was awakened by this expedition, and Mr. Schoolcraft's narrative of it was hurried into press under the pressure of the public clamor for its results. The book was published in May, 1821.

Mr. Schoolcraft shortly afterward embarked, with General Cass, on another expedition. The route lay from the present site of Toledo, up the Miami of the lakes, down the Wabash and Ohio to Shawneetown, overland across the "knobs" and prairies, taking a famous locality of fluor-spar on the way, to St. Louis; thence up the Illinois to the rapids and on horseback to Chicago, stopping to find the fossil tree in the bed of the Des Plaines. In Chicago, a treaty was made with the Pottawattamies for the surrender of about five million acres of land, to which Mr. Schoolcraft should have given his signature among the others, but he was too ill—"did not, indeed, ever expect to make another entry in a human journal." The incidents and observations of the journey have been published as Travels in the Central Portions of the Mississippi Valley. In the next year (1822) Mr. Schoolcraft was appointed Indian agent at Sault Ste. Marie, of which he says, giving his reasons for accepting it: "I had now attained a fixed position; not such as I desired in the outset and had striven for, but one that offered an interesting class of duties, in the performance

of which there was a wide field for honorable exertion, and, if it was embraced, also of historical inquiry and research. The taste for natural history might certainly be transferred to that point, where the opportunity for discovery was the greatest." The position afforded him excellent opportunities for studying the Chippewa language and Indian mythology and superstition, characteristics, and customs, of which he made the best use. He determined to be a laborer in the new field of Indian studies. His diary during the whole term of his office shows him leading a busy and varied life. We find in it notes on his subjects of study, of his readings on various general topics, observations on the natural features of the region, remarks on mineralogical specimens, and incidents of official work.

Mr. Schoolcraft spent the winter of 1824–'25, on leave of absence, in New York, where he superintended the printing of his Travels in the Central Portions of the Mississippi Valley. "Society" was much interested in Mrs. Schoolcraft, the "Northern Pocahontas," a lady of aristocratic Irish descent on one side, and tracing her ancestors on the other side to the royal house of the Chippewas, who was withal, having been educated abroad, highly accomplished and refined in her manners. She was the daughter of Mr. John Johnston, of Sault Ste. Marie, who had married the daughter of Wabojeeg, a distinguished Chippewa chieftain. In 1825 he attended a convocation of the Indian tribes at Prairie du Chien, where a treaty was signed, through which it was hoped internal disputes between the tribes might be settled by fixing the boundaries to their respective territories. In the next year he attended a similar gathering of the Chippewa tribes at Fond du Lac, where the principles of the treaty of Prairie du Chien were reaffirmed, and a new treaty was made, under which the Indians acknowledged the sovereign authority of the United States; ceded the right to explore and take away the native copper and copper ores, and to work the mines and minerals in the country; and provision was made for the education of the Indians and their advancement in the arts. The system of Indian boundaries established by these treaties was completed by the treaty of Butte des Morts, August, 1827. The three treaties embodied a new course and policy for keeping the tribes in peace, and were founded "on the most enlarged consideration of the aboriginal right of fee simple to the soil." In 1827 he was elected a member of the Legislative Council of the newly organized Territory of Michigan—an office which was not solicited, and was not declined. As a member of this body during four sessions, he directed his attention to the incorporation of a historical society; to the preparation of a system of township names derived from the aboriginal languages; and to some efforts for bettering the condition of the natives.

A proposition was made to Mr. Schoolcraft in 1828 to go as one of the scientific corps of an exploring expedition which the Government contemplated sending to the south seas, under the direction of the Secretary of the Navy. In his reflections on the prospects of this expedition and the acquisitions to knowledge that might be expected to accrue from it, he regarded the experiments of Dr. Maskelyn, denoting a greater specific gravity in the central portion of the globe than in its crust, as opposed to a theory that was then advocated of an interior void. Yet he thought "we are advertised, by the phenomena of earthquakes, that this interior abounds with oxygen, hydrogen gas, caloric, and sulphur, and that extraordinary geological changes are affected by their action. It does seem improbable that the proposed expedition will trace any open connection with such an interior world; but it may accumulate facts of the highest importance." There was something, however, about the getting up and organization of the expedition which he did not like, and an apprehension whether Congress would not cripple it by voting meager supplies and outfits. He declined to go.

A note from Mr. G. W. Featherstonaugh, giving a disparaging view of American scientific achievement, and inclosing the prospectus of a journal designed to correct these things, gave Mr. Schoolcraft opportunity for bearing strong tribute to the genuineness of real American scientific research. The critic's remarks might be true as to a certain class, who had not made science a study; but, if applied to the power and determination of the American mind devoted to natural history, it was "not only unjust in a high degree, but an evidence of an overweening self-complaisance, imprecision of thought, or arrogance. No trait of the American scientific character has been more uniformly and highly approbated by the foreign journals of England, France, and Germany than its capacity to accumulate, discriminate, and describe facts. For fourteen years past, Silliman's Journal of Science, though not exclusively devoted to natural sciences, has kept both the scientific and the popular intelligent mind of the public well and accurately advised of the state of natural science the world over. Before it, Bruce's Mineralogical Journal, though continued but for a few years, was eminently scientific; and Cleaveland's Mineralogy has had the effect to diffuse scientific knowledge not only among men of science, but other classes of readers. In ornithology, in conchology, and especially in botany, geology, and mineralogy, American mind has proved itself eminently fitted for the highest tasks."

The Michigan Historical Society was founded, chiefly through Mr. Schoolcraft's instrumentality, in 1828, and the Algic Society on February 28, 1832. The latter organization had in view the

reclamation of the Indians, and, connected with this, the collection and dissemination of information respecting their language, history, traditions, customs, and character; their numbers and condition; the geological features of their country, and its natural history and productions. It also proposed some definite means of action for furthering the moral instruction of the Indians, and for helping the missionaries in all work for their benefit. As president of this society, Mr. Schoolcraft was asked to lecture on the grammatical construction of the Algonquin languages as spoken by the Northwestern tribes, and to procure a lexicon of it; also to deliver a poem on the Indian character at the annual meeting of 1833. Other literary efforts of this period were, an address before the Historical Society of Michigan in 1830, and an address, in 1831, before the Detroit Lyceum, on the natural history of the Territory. In the summer of 1832 Mr. Schoolcraft, under a commission from the Government, organized and commanded an expedition to the country upon the sources of the Mississippi River. The primary object of the expedition was to extend to the Indians living north of St. Anthony's Falls the measures previously taken with those south of that point, to effect a pacification; also, to endeavor to ascertain the actual source of the river. He ascended the St. Louis from Lake Superior to Sandy Lake summit, and passed thence direct to the Mississippi six degrees below the central island in Cass Lake, which was till then the ultimate point of geographical discovery. Thence he went up the river and its lakes, avoiding too long circuits of the stream by portages, to the junction of the two branches, where by the advice of his Indian guide he took the left-hand, or Plantagenian branch, to Lake Assawa, its source. Thence he went by portage, a distance of "twelve resting-places," to Itasca Lake, which he struck within a mile of its southern extremity. The lake was judged to be about seven miles in length, by one or two broad; "a bay, near its eastern end, gave it somewhat the shape of the letter *y*." The discoverer returned, through the stream and its lakes, to St. Peter's.

The narrative of this expedition was published in 1834; and was republished, with the account of the expedition of 1820, in 1853, under the title, Narrative of an Exploratory Expedition to the Sources of the Mississippi River in 1820, completed by the Discovery of its Origin in Itasca Lake in 1832. The whole of Mr. Schoolcraft's earlier life and work up to this time is recorded, mostly from day to day, in his Personal Memoirs of a Residence of Thirty Years with the Indian Tribes on the American Frontiers, etc., 1812 to 1842, a book having "the flavor of the time, with its motley incident on the frontier, with Indian chiefs, trappers, government employés, chance travelers, rising legislators, farmers, ministers of the gospel, all standing out with more or less of indi-

viduality in the formative period of the country." This book abounds with evidence of Mr. Schoolcraft's scientific and literary activity, as well as of his efficiency in work in whatever field. As early as 1820 we find a letter from Amos Eaton, asking him for information for the second edition of his Index to Geology, respecting the secondary and alluvial formations and the strata of the Rocky Mountains. Dr. Samuel Mitchell writes him, in 1821, about the shells and other specimens he has sent, including a "sandy fungus," and inviting specimens for the cabinet of the Emperor of Austria. Profs. Silliman and Hall acknowledge the value of his examination of the mining regions of Missouri; Prof. Silliman asks for articles for his journal; and Sir Humphry Davy thinks his book would sell well in England. Prof. Cleaveland writes him, in 1827, that he is about preparing a new edition of his work on mineralogy, and solicits the communication of new localities. In the same year Mr. Schoolcraft himself writes that the collection he made in Missouri, etc., in 1819, appears to have had an effect on the prevalent taste for those subjects, "and at least it has fixed the eyes of naturalists on my position on the frontiers." Mr. Peter S. Duponceau addresses him, in 1834, on the structure of the Indian languages, "in terms which are very complimentary, coming, as they do, as a voluntary tribute from a person whom I never saw, and who has taken the lead in investigations on this abstruse topic in America." He pronounces Mr. Schoolcraft's book on the Chippewa languages one of the most philosophical works on the Indian languages which he has ever read. In another letter Mr. Duponceau acknowledges having used Mr. Schoolcraft's grammar, giving due credit, in preparing a prize essay for the Institute of France, on the grammatical structure of Indian languages. Dr. Thomas H. Webb, of Providence, in 1835, notifies him of his election as an honorary member of the Rhode Island Historical Society, and asks about aboriginal inscriptions on rocks. The Massachusetts Historical Society, in 1836, asks him to proceed with his work on the Ojibway language, complete it, and let the society publish it. John J. Audubon asks for aid in preparing his work on American quadrupeds. There are numerous notices of specimens that have been sent to Mr. Schoolcraft to pass upon, and solicitations from persons representing the principal magazines, to contribute of the results of his researches.

A new disposition of official posts having been made, Mr. Schoolcraft transferred his residence in 1837 to Michilimackinac or Mackinaw. Thence he removed, in 1841, to New York, where he expected to find the surroundings more favorable to the collation and publication of the results of his observations on the red race, whom he "had found in many traits a subject of deep

interest; in some things wholly misunderstood and misrepresented; and altogether an object of the highest humanitarian interest." But the publishers were not yet prepared in their views to undertake anything corresponding to his ideas. In the next year he carried out a long-deferred purpose of visiting England and continental Europe, attending the British Association at Manchester. On his return he made a tour through western Virginia, Ohio, and Canada. In 1875 he was appointed by the Legislature of New York as a commissioner to take the census of the Indians of the State, and collect information concerning the Six Nations. The results of this investigation were embodied in his Notes on the Iroquois, a second enlarged edition of which was published in 1847. The latter part of his life was spent in the preparation—under an act passed by Congress in 1847—of an elaborate work on all the Indian tribes of the country, based upon information obtained through the reports of the Indian Bureau. This work—which was published in six quarto volumes—is described in Duyckink's Cyclopædia of American Literature as covering a wide range of subjects in the general history of the race; their traditions and associations with the whites; their special antiquities in the several departments of archæology in relation to the arts; their government, manners, and customs; their physiological and ethnological peculiarities as individuals and nations; their intellectual and moral cultivation; their statistics of population; and their geographical position, past and present.

Mr. Schoolcraft became interested in religion at an early period in his career, and his journals show him ever more earnestly co-operating in local religious movements; furthering the progress of missionary effort among the Indians, by whatever denomination; laboring for the promotion of temperance among them; and taking the lead in whatever might contribute to their well-being or to the repression of wrong against them. His literary activity was prolific, and appears to have been nearly evenly divided between poetry, Indian lore and ethnology, and the objects of his explorations and scientific investigation. Besides books of poems and the narratives already named, he published Algic Researches, a collection of Indian allegories and legends (1839); Oneota, or the Characteristics of the Red Race in America (1844–'45), republished in 1848 as The Indian and his Wigwam; Report on Aboriginal Names and the Geographical Terminology of New York (1845); Plan for investigating American Ethnology (1846); The Red Race of America (1847); A Bibliography of the Indian Tongues of the United States (1849); and American Indians, their History, Condition, and Prospects (1850). He received the degree of LL. D. from the University of Geneva in 1846; and was a member of many learned societies.

CORRESPONDENCE.

AGRICULTURE ON THE PLAINS.

Editor Popular Science Monthly:

IN the February number of The Popular Science Monthly was published an article, by Stuart O. Henry, entitled Rainfall on the Plains. Mr. Henry claims that the rainfall on our plains has not increased to any appreciable extent since the first settlement; and he says that the general impression that settlement and cultivation traveling westward have been attended by a gradual increase of rainfalls is a "remarkable fallacy." He concludes that agricultural operations can never be successfully carried on west of a line about the ninety-eighth meridian, and that attempts to utilize the regions named for purely agricultural purposes, without artificial irrigation, will only result in calamitous failure. Mr. Henry makes the statement that "the reports of the Kansas and Nebraska Boards of Agriculture will show that, in the territory lying west of the ninety-eighth meridian in those States, the acreage of land actually under cultivation, when compared with the whole area of that territory, is almost insignificant." After seventeen years of residence in southwestern Nebraska, near the one hundredth meridian, I am convinced that Mr. Henry is correct as to the absence of an increase of rainfall; but his conclusions are very erroneous, and must have been formed without information as to the great growth in wealth and population in the region west of the ninety-eighth meridian during the last ten years. The statement that the cultivated land west of the ninety-eighth meridian in Kansas and Nebraska is insignificant when compared with the whole area of that territory may have been true ten years ago, but at the present time it is far from the truth. The writer believes that no increase of rainfall has ever been necessary to fit the country named for profitable farming, but that the rainfall has *always been sufficient*, and that the obstacles to farming that have existed resulted from the *newness* of the country, rather than from lack of rain, and that these obstacles are gradually disappearing as the country settles up, and will wholly disappear when the country becomes as densely settled as are the States of Iowa and Illinois.

Mr. Henry's gloomy statements seem like an echo of predictions made by sundry scientific gentlemen twenty years ago concerning the plains of Kansas and Nebraska; and he might be aptly compared to a modern Rip Van Winkle, who has just awakened after a twenty years' sleep, ignorant of the wonderful growth that the country west of the ninety-eighth meridian has made. When he penned the lines quoted, was he aware that Jewell County, Kansas, which lies west of the ninety-eighth meridian, is the champion corn-producing county in the Union? Was he aware that nearly one half of the wealth and population of the State of Nebraska is to be found west of the ninety-eighth meridian? The report of the Nebraska Board of Agriculture for the year 1889 has not been issued, but we have the report for 1888. The crops in Nebraska in 1888 were not as good as in 1889, nor was there as much ground in cultivation. I give below some statistics taken from the report for 1888 making a comparative statement of the amount of wheat, corn, and potatoes raised east of the ninety-eighth meridian and west of that meridian in the State of Nebraska. It will be admitted by all that wheat, corn, and potatoes require as much moisture as do any farm products. It must be borne in mind that many of the western counties are very new and their capabilities not developed; but enough is shown to completely disprove Mr. Henry's statements. In the counties of Nebraska that lie *west* of the ninety-eighth meridian there were raised in 1888 of corn, wheat, and potatoes:

Corn	52,847,469 bushels
Wheat	7,088,688 "
Potatoes	8,626,145 "

In the counties in Nebraska lying east of the ninety-eighth meridian there were raised in 1888:

Corn	93,379,870 bushels
Wheat	4,876,190 "
Potatoes	2,724,996 "

It will thus be seen that the counties west of the ninety-eighth meridian produced about thirty-six per cent of all the corn, about sixty per cent of all the wheat, and about seventy-six per cent of all the potatoes that were raised in 1888 in Nebraska, and as a matter of fact a good portion was raised west of the one hundredth meridian. Reference to the same report shows that in 1888 there were 2,611,337 acres of improved land in the Nebraska counties lying west of the ninety-eighth meridian. These statistics clearly demonstrate that the improvements there made are far from "insignificant," and, could the statistics for 1889 be had, we would, without doubt, have a still more encouraging showing.

A. E. HARVEY.

ORLEANS, NEBRASKA, *March* 26, 1890.

PUBLIC SCHOOLS AS AFFECTING CRIME AND VICE.

Editor Popular Science Monthly:

UNDER the above heading Mr. Reece presented some statistics in The Popular Science Monthly for January, apparently showing a high and increasing per cent of crime in those communities where there

were the fewest illiterates as compared with those where there were the most. In the succeeding numbers of the Monthly two writers, apparently accepting the statistics without question, have proceeded to draw conclusions from them. Some one has wittily said that "nothing can lie like figures"; and certainly any one who deals much with statistics knows that unless carefully and thoughtfully handled they are capable of giving the most deceptive results. For this reason startling conclusions should not be accepted without careful consideration. There is getting to be too wide a tendency to accept statistics as decisive proof on any subject without regard to how they were prepared or discussed.

In the January Lend a Hand, Mr. David C. Torrey carefully discussed the records of crime in Massachusetts, which was one of the States where Mr. Reece found his highest per cent of criminals, and some of his results seem worthy of quoting, as throwing much light on this subject:

From 1850 to 1885 the total commitments increased from 8,761 to 26,651; in the first-mentioned year, 1 to 113 inhabitants; in the second, 1 to 72 inhabitants. It is found, however, on investigation, that the increase is almost entirely confined to crimes against public order and decency, while the commitments for the more serious crimes against persons and property have not even kept pace with the growth of population. The following statistics for the years since 1865 in which a census has been taken proves this statement. This division by crimes was first made in the returns to the State in 1865, and was not made in 1875:

YEAR.	COMMITMENTS FOR CRIMES AGAINST	
	Persons and property.	Order and decency.
1865.....	3,975	5,760
1870.....	5,097	11,290
1880.....	3,779	13,274
1885.....	4,389	21,812

For the more serious crimes in 1865 and 1870, the average commitments were 1 to 301 inhabitants, while in the years 1880 and 1885 they were 1 to 436 inhabitants. The increase in commitments was for less serious crimes exclusively, and there was an actual decrease in commitments for more serious crimes, in proportion to population, of forty-four per cent. The larger portion of the less serious crimes, those for which commitments are increasing, are crimes of intemperance; so Mr. Torrey makes a second division of crimes, separating those of intemperance from all other crimes. The returns to the State permit of this division for a longer period:

YEAR.	Commitments for intemperance.	Commitments for all other crimes.	Total commitments.
1850.....	3,341	5,420	8,761
1855.....	8,221	7,811	16,032
1860.....	3,442	8,322	11,764
1865.....	4,302	5,616	9,918
1870.....	9,350	7,250	16,600
1875.....	.....	.....	24,548
1880.....	10,962	6,091	17,053
1885.....	18,701	7,950	26,651

This division shows that the total increase in all crimes other than intemperance, taken together, has been only fifty per cent (population not considered), but that commitments for intemperance have increased nearly five hundred per cent. The commitments which were not for intemperance are compared with the population of the State with the following results: In 1850, 1 commitment to 183 inhabitants; in 1855, 1 to 144; in 1860, 1 to 147; in 1865, 1 to 225; in 1870, 1 to 201; in 1875, no statistics; in 1880, 1 to 280; in 1885, 1 to 244. From 1850 to 1865 the average commitments for crimes other than intemperance were 1 to 174 inhabitants, while from 1870 to 1885 it was 1 to 241 inhabitants. Thus a decrease of thirty-eight per cent is shown in all crimes other than intemperance during a period of seventeen years.

The question of crime in Massachusetts thus resolves itself into a question of intemperance, pure and simple for it is owing to intemperance alone that there is an increase of commitments. Mr. Torrey proceeds to show that the increasing commitments for intemperance do not necessarily prove an increase of intemperance. The public has a different opinion of the crime of intemperance from what it has of other crimes. The commitments for more serious crimes could not increase without an increase of those crimes; but, because so few of the men who drink to excess are committed, there is abundant opportunity for an increase in commitments for intemperance without an actual increase of intemperance. In thirty-five years public sentiment has been aroused against intemperance, and the increased commitments caused by this sentiment and the changes in law which it has brought about are the inadequate grounds which warrant claims that crime is increasing in Massachusetts. The State seems still to have encouragement to continue its schools and its reformatories and its churches, with faith that it can not only take care of the children born to it, but also that it can assimilate to its social order those which it is forced to adopt.—*Boston Post.*

H. Helm Clayton,
Blue Hill Observatory, Readville, Mass.,
March 30, 1890.

EDITOR'S TABLE.

PRACTICAL ECONOMICS.

IN last month's Table we had a few words upon the discredit into which what is sometimes called the "orthodox" political economy has fallen among practical men. It is a pleasure to be able to call attention to a book which furnishes a signal example of the way in which economical studies should be pursued. We refer to the volume brought out a few months ago by Mr. D. A. Wells, under the title of Recent Economic Changes. Mr. Wells is not a dogmatist, though it is evident he has sufficiently definite opinions of his own. He conceives it to be his main business to marshal the facts that seem to him capable of explaining the present material condition of society, and of indicating the course that things are likely

to take in the future. He has no special theory to advocate, and he promises no speedy renovation of society if only his advice be taken. He knows too much to be a visionary; he has too firm a hold on the actual to be carried away by the merely ideal or fanciful. He finds no fatal flaw in the present social system; he does not see, in fact, how, given human nature as it is, things could be very different from what they are. At the same time he is an earnest believer in progress; but he thinks that progress depends more upon individual adaptation to necessary conditions of existence than upon any cunningly contrived devices for an improved distribution of the products of industry. In a word, he is a man whom the devourer of contemporary socialistic romances would find a little dull, but whom the practical man of business would find both interesting and instructive in the highest degree. As a large part of Mr. Wells's book appeared originally in the pages of this magazine, we may presume that many of our readers have a more or less vivid recollection of the course of his argument. What Mr. Wells set himself chiefly to do was to trace to its cause or causes the present disturbed condition of the world from an economic point of view. Given such a problem, a writer who wished to create an immediate sensation would bring forward some theory about the land, or about the currency, or about monopolies, or about the waste involved in competition, and would declare with much emphasis and vainglory that he alone had the true key to the whole situation. Mr. Wells is more modest. All he professes to see is that the rapid pace of invention and discovery in the modern world is sufficient to account for enormous vicissitudes both in the money market and in the labor market. Capital has been destroyed in huge blocks and recreated by new methods; labor has been forced to quit one employment after another and find new openings for itself. The course of business has become more and more difficult to calculate, and only the stronger heads and more resolute wills have been able to hold their own amid the changes and chances of the hour.

Mr. Wells does not deal in mere generalities. He treats separately each aspect of his subject, and under every head gives facts in abundance—"modern instances," as Shakespeare expresses it. He shows what has been done in the way of opening new routes; and, in the case of the Suez Canal, he traces to that one cause the most momentous results as regards the course of trade. He discusses very fully the effects of the cheapening of transportation by land and by sea, showing how, to this cause, must be attributed much of the agricultural depression existing in different parts of the world. He dwells on the inventions and discoveries by which manufactures have been cheapened, and labor constantly displaced and again provided for. He shows how improved methods of farming render less efficient ones unprofitable, and how little good has been done to the farming population by the homestead and other exceptional laws passed for their benefit—nay, how they have been injured by the overzeal of their friends in the Legislature. He discusses the effect of restrictions on trade, and shows in what idle fashion the governments of the world, with one or two exceptions, handicap their own commerce in the effort to injure that of their neighbors, and how the effect of the whole protectionist madness is simply to place a heavy drag upon the industrial energy, not to say upon the conscience, of mankind. We can not pretend, however, in this place to give even the most rapid summary of the contents of Mr. Wells's volume. Suffice it at present to say that he has described with great fullness and, so far as we can judge, with great accuracy, the conditions under which the business of the world is now being carried on, and the circumstances that have

concurred to make the present epoch one of peculiar commercial and industrial unrest.

What is the lesson, then, we are to draw from Mr. Wells's pages, so far as the social problems of our own time are concerned? We learn from it that there is nothing radically unsound in our social system; and, further, that the total effect of all the changes of the last twenty-five or thirty years has been to improve materially the condition of the working classes. Hours of labor are not as long on the whole as they used to be; wages are higher; and the purchasing power of money is greater. What is the case, however, is that, in the rush of change which has marked recent years, there is a constant selection and reselection of the better men, and that the worse—the less competent, the less efficient in every way—find themselves relegated to poorer conditions of life. There is an upward current and there is a downward current: those who move up do not spend much time or energy in singing the beauties of the present system; but those who are moving down waste no small amount of the little energy they have in bewailing its defects, and, with the help of a few literary gentlemen of lively sympathies and facile speech, manage to create a widespread impression that a world in which they do not get all they would like must be a very badly governed world indeed. The whole social question seems to lie here, that some, through natural deficiencies of one kind or another, can not, in any satisfactory degree, adapt themselves to the world as it is. We should be sorry to profess, or to feel, indifference to the problem even as thus stated; but what are we going to do about it? The true methods of reform are of slow application; and immediate suffering it is impossible altogether to prevent. The path of social reform, we are strongly persuaded, lies mainly along these three lines:

1. Diminution of state interference with private liberty, including state restrictions on trade and state encouragement of trade.

2. Constant inculcation of the doctrine of individual responsibility, and constant effort to mold better individuals.

3. An honest, vigorous, and simple administration of justice.

These three conditions (to which many minor but still important ones might be added) are all intimately connected. For example, how can we preach the doctrine of individual responsibility with any success, if the individual is daily surrounded by a closer and closer network of arbitrary enactments, designed at once to abridge his liberty and to relieve him of the exercise of judgment and caution? And how can we have a really efficient administration of law, till law itself undergoes a pruning, and is brought down to its necessary elements?

To return, however, to Mr. Wells's book. We are glad to see its merits very frankly acknowledged in an article published in the March number of Macmillan's Magazine, the writer declaring that Mr. Wells deals with his subject "in a manner altogether superior to anything which this country (England) can show." We shall only say in conclusion that the book is an eminently useful one to-day and will remain so for many years to come. A careful perusal of its pages would clear infected brains of many sickly fancies.

TRAINING IN REALITIES.

It is a long time since an earnest thinker proclaimed that wisdom was the principal thing, and that with all a man's gettings he should strive to get understanding; but whether the world to-day—even those who regard the utterance as carrying with it more than human authority—can be said to pay due heed to the maxim is more than doubtful. Instead of wisdom, men exalt opinion,

and traditions are taught where truth should be explored. We have large and influential schools decrying the use of reason, and we have millions of people to-day trying to think true what their common sense tells them is not true. All this does not make for the world's peace or stability. It will not be really well with society until men generally are brought to recognize that there is such a thing as truth, and that its claims upon them are paramount. Our systems of education need to be revolutionized. When a young person leaves school or college nowadays, do we expect to find that his or her judgment has been developed in practical things? Do we expect to find a keen sense of what is true, a quickness in distinguishing shams from realities, and a well-established habit of yielding, upon all disputed questions, to the greater weight of evidence? Nothing of the kind. We look for a little knowledge of arithmetic and mathematics generally, a modicum of geography and grammar, a smattering of literature, a few confused notions of natural science, a discontinuous skeleton of historical knowledge, and not much else. The judgment has not been trained, the sense of truth has not been trained, nor has any insight worth mentioning been given into the realities of life and duty. We do not blame the teaching fraternity for this; society as a whole is responsible. The want of interest in truth as truth, the lack of perception of its importance, is a broad social characteristic of the time, and floods the schools just as it floods the market-place, the press, and the pulpit. But, while we do not in any special manner blame the teaching profession, we feel like summoning all serious men to consider whether a very decided and vigorous effort should not be made to place our schools upon a higher level in this respect. No one can doubt that, if our minds were set upon it, a simple gymnastic might be devised which would, from the outset, train childish minds in the perception of truth and lead them on from stage to stage in the acquisition, not of sham but of real knowledge. A child in course of education should never be removed from actual contact with the world about him. He should be made to feel that every general rule given to him is merely a summary expression of a number of concrete examples. He should be early familiarized with the method of proof, and in every possible way encouraged to ask for proofs. He should be made to realize the activity of his own senses; to feel that knowledge is coming to him through those avenues; and that, only as it so comes, is it entitled to be considered real knowledge.

Such a system of education as we have hinted at would banish the intellectual poverty and squalor of our time; and this could not be done without an immense improvement of general social conditions. The sentimentalists of our day bestow a huge amount of sympathy upon the victims of poor wages; but they do not grieve as they might over the victims of poor thoughts and disordered imaginations. The dust and dirt heaps that obstruct the entrance to thousands of minds are not visible as material masses; but they are there all the same, and the injury they cause is greater than any due to mere limitation of material conditions. The land is full of delusions, and scarcely anywhere do we see any clear consciousness of the grand possibility open to the human race of co-operating in the discovery and application of truth, including, of course, and in the first place, the laws of social well-being. We too readily resign ourselves to the idea that men's opinions must differ by the whole circle of possible thought, and that a common standard of truth is unattainable. Well might the reproach be launched against this generation, "O ye of little faith!" Amid the manifold and ever-widening discoveries of science we resign ourselves to intellectual chaos, as if there were no common heritage of truth for us all, or as if human minds

were not all made essentially on the same pattern. What the times seem to call for is some association of men and women bent on nothing else than the introduction, primarily into our educational systems, but as much as possible into social life generally, of a supreme regard for that which is real.

LITERARY NOTICES.

PRACTICAL HINTS FOR THE TEACHERS OF PUBLIC SCHOOLS. By GEORGE HOWLAND. International Education Series, Vol. XIII. New York: D. Appleton & Co. Pp. 198. Price, $1.50.

THIS volume deals with the practice rather than with the theory of education. It tells what to do, and does not concern itself with any comprehensive scheme of educational philosophy. The author is superintendent of the public schools of Chicago, and the several chapters of this volume are based upon papers read before the teachers of that city and vicinity. The author has not aimed to produce an exhaustive and systematic treatise, but has confined his attention to the following ten topics: Moral training in city schools, the character of the teacher, the place of memory in school instruction, elements of growth in school-life, the scholarship aimed at in the school, the teacher in the school-room, how the school develops character, the class recitation, the school principal, and the work of the superintendent. The pages of the book are dominated by the personality of the author, and the things and practices recommended are such as his experience tells him are good. In regard to moral training, the subject that he treats first, he has no faith in text-books or special instruction; he would trust entirely to "the quiet suggestion, the fitly chosen word, the interested inquiry, the look, the unfeigned sympathy, the favored opportunity, the firm but calm decision of the loved and loving teacher." In other subjects, however, he would depend altogether upon books. The sesame to all progress, he says, is found inscribed on the printed page. In the six years before the child comes to school he has had a training without books which, as Mr. Howland affirms, has been very effective. "He has early learned that fire will burn, that cold will freeze, and knows, beyond the power of Webster or Worcester to tell him, the meaning of burn and freeze; and by many a bump has the force of attraction been impressed upon him." He has learned a language, and has acquired much other knowledge. By similar means the Indian acquires a wonderful training of his senses, his hands, and his mental powers. "He learns to do," says Mr. Howland, "in the only true way, by the doing." In acquiring a knowledge of language the author recommends this same process. Correct use of words and a nice appreciation of their meanings and force are to be secured, he says, "not from dictionary, but from use alone." That the teacher should learn by this method, however, he deems inadmissible. In his chapter on "The School Principal" he says: "We learn to do by doing, is one of those aphoristic half-truths well suited to catch the ear and delude the mind of the unthinking. We may acquire a mechanical facility by repeated doings of what we already know how to do, but we learn to do by learning how other people do, and by the aid of this knowledge striving to do something better." The volume is especially marked by an energetic character and a confident tone which assure the reader of the real interest of the author in the work of the teacher.

FIRST LESSONS IN POLITICAL ECONOMY. By FRANCIS A. WALKER. New York: Henry Holt & Co. Pp. 323. Price, $1.25.

THE special purpose of this book is to bring political economy within the grasp of youth from fifteen to seventeen years of age. The author has not made it childish by restricting himself to "words of two syllables," or by any similar device. The character which he has aimed to give the volume in order to adapt it to young pupils consists in "a clear arrangement of topics; a simple, direct, and forcible presentation of the questions successively raised; the avoidance, as far as possible, of certain metaphysical distinctions which the author has found very perplexing to students of even a greater age; a frequent repetition of cardinal doctrines; and, especially, a liberal use of concrete illustrations, drawn from facts of common

experience or observation." The fact that one purpose of the treatise is to interest beginners in the subject of political economy has also modified its character. "The author has not held himself, as strictly as he has sought in previous works to do, to the treatment of political economy as a science, to be distinguished from the art of political economy. He has allowed himself great freedom in assuming that certain results are desirable in themselves, and certain other results undesirable; and he has sought to show how these may be avoided and those attained. Much, which, in his other works, has been treated as belonging to the applications of political economy, is wrought into the substance of the present treatise." The work is divided into two chief parts, one treating of "Production and Exchange," the other of "Distribution and Consumption." Each section is numbered and has a title, and the volume is indexed.

FUEL AND ITS APPLICATIONS. By E. J. MILLS and F. J. ROWAN. Illustrated. Philadelphia: P. Blakiston, Son & Co. Pp. xx+802. Price, $7.50.

IT is one of the obstacles to gaining a competent knowledge of technology that its manuals become almost worthless when a few years old, but it is the glory of the sciences on which technology depends that they advance fast enough to make these books antiquated so quickly. This is especially true of the group of industries based upon the science of chemistry. In order to supply the lack of a comprehensive, authoritative *new* work dealing with these industries, a series of volumes has been projected, under the general title "CHEMICAL TECHNOLOGY, or Chemistry in its Applications to Arts and Manufactures." It will be edited by Charles E. Groves, F. R. S., editor of the "Journal of the Chemical Society," and William Thorp, B. Sc. As much of the matter of Richardson and Watts's "Chemical Technology" as is available, especially the historical portions, will be incorporated in the new work. Of this series the present volume is the first. The most important sections of the general field, to be covered in later volumes, are "Lighting," "Acids and Alkalies," "Glass and Pottery," "Metallurgy," "Textile Fabrics," "Leather, Paper, etc.," "Coloring Matters and Dyes," "Oils and Varnishes," "Brewing and Distilling," "Sugar, Starch, Flour," etc. The present volume treats of "Fuel and its Applications" generally; its special employment in various branches of chemical manufacture being preserved for detailed consideration in the volumes devoted to the special subjects enumerated above. In the chapters devoted to the production of fuel, tables are given showing the composition of the different woods and coals, together with information concerning the formation of peat, lignite, and coal, the world's production of coal, explosions in mines from fire-damp and coal-dust, etc. The figures representing the output of coal in Britain and other countries show the enormous development which has taken place in the fuel industry all over the world. Methods of burning charcoal, both in heaps and kilns; and methods of coking, in heaps and in ovens, are described, with illustrative views and diagrams. On the continent of Europe, methods of cleaning, washing, and classifying coal have reached a great degree of elaboration, and the practice in Britain has progressed somewhat in the same direction. Considerable space is devoted to these methods, and the machines employed in them. The most marked advance in respect to the manufacture and application of fuels in the past generation has been in the control and utilization of gases. The waste gases from coking ovens are now collected for their ammonia, tar, and other by-products, the gases from blast-furnaces using coal and from gas-producers are also made to yield these products; and great advance has been achieved in the extraction of ammonia in shale distillation. More important than these is the use of coal-gas, and in America of "natural" gas also, as fuel. The methods and appliances for using gaseous and also liquid fuel receive a general representation in this volume, and copious references are given for specialists who may wish to study particular branches of the subject. The portion of the volume devoted to the application of fuel is introduced by chapters on the theory of heat and the nature of flame. The matters of chimney-draught, forced combustion, and smoke prevention are then taken up. The special application of fuel considered first

is in domestic heating. The open fireplace and several ventilating fireplaces, and the "American" stove, are mentioned; but most space is given to gas heating and cooking stoves. Heating by means of hot air, hot water, and steam also receives attention. The application of fuel to vaporization, i. e., the heating of boilers, is next treated; and from this subject the authors pass to the evaporation of liquids and distillation. The drying of wood and malt, baking bread, and firing brick and porcelain, also have a place. Furnaces for metallurgical and other technological operations are next treated, and an important chapter follows on gas-furnaces, including those using the regenerative principle. The closing chapter deals with the practical effect of fuel. A series of tables giving analyses of coals follows. Throughout the book exact information in regard to the several divisions of the subject is furnished in tables and diagrams. The volume contains seven plates and six hundred and seven other illustrations, and is provided with an adequate index.

LIBERTY AND A LIVING. By PHILIP G. HUBERT, Jr. New York and London: G. P. Putnam's Sons. Pp. 239.

THIS book is described in its sub-title as the record of an attempt to secure bread and butter, sunshine and content, by gardening, fishing, and hunting. One of its mottoes is, "The royal peace of a rural home." The author, a writer on New York newspapers, wearied with the monotony and drudgery of city life, sought a way in which he could spend his time in the outdoor season profitably in the open air, and without giving up the winter residence in the city which his profession demanded. He found a place on the sea-coast of Long Island which afforded a home, garden, wood-lot, access to the water for boating and fishing, and hunting privileges. The book describes his life there, and the moral and practical lessons derived from it. The transcript of the diary of a week gives a realistic picture of the average life. The home and its arrangements, the garden-work and its returns, the fishing, the bee-raising, the advantages derived from the possession of a wood-lot, and the balance of advantages and disadvantages, are described in successive chapters. The balance is shown to be decidedly in favor of the country, pre-eminently so to those who seek quiet, rational enjoyment, with health, who desire leisurely culture without excitement, who are willing to live independently of fashion, and who do not attach an exaggerated importance to show.

JONATHAN EDWARDS. By ALEXANDER V. G. ALLEN, D. D. Boston and New York: Houghton, Mifflin & Co. Pp. 401. Price, $1.25.

THIS is the first volume of the series of "American Religious Leaders," or biographies of men who have had great influence on religious thought and life in the United States, in which it is intended, besides depicting great figures in American religious history, to indicate the leading characteristics of that history, the progress and process of religious philosophy in America, the various types of theology which have shaped or been shaped by the various churches, and the relation of these to the life and thought of the nation. The present volume relates to the earliest and probably the greatest of those leaders—the thinker who, along with Benjamin Franklin, American and foreign critics agree in naming as representative of American intellectual activity in the eighteenth century. Prof. Allen's aim in this biography has been "to reproduce Edwards from his books, making his treatises, in their chronological order, contribute to his portraiture as a man and as a theologian." Something more than a mere relation of facts seemed to be demanded in order to justify the endeavor to rewrite his life. What we most desire to know is, what he thought, and how he came to think as he did. "Edwards is always and everywhere interesting, whatever we may think of his theology. On literary and historical grounds alone no one can fail to be impressed with his imposing figure as he moves through the wilds of the New World." Edwards's life is full of dramatic incident, and his writings furnish ground for fruitful study—a study which he that would understand the significance of New England thought in the last century, and under its later aspects as well, will find indispensable. The summation of the result of Edwards's work is concluded with the assertion that "all who accept the truth that divine things are known to be divine be-

cause humanity is endowed with the gift of direct vision into divinity, are accepting what Edwards proclaimed, what constitutes the positive feature of his theology. There are those who have made the transition from the old Calvinism, through the mediation of this principle, to a larger theology as if by a natural process. Among these typical thinkers were Thomas Erskine, McLeod Campbell, and Bishop Ewing in Scotland, or the late Mr. Maurice in England. These and such as these, in whom the God-consciousness is supreme, are the true continuators of the work of Jonathan Edwards."

EXERCISES IN WOOD-WORKING; WITH A SHORT TREATISE ON WOOD. By IVIN SICKELS. New York: D. Appleton & Co. Pp. 158, with Plates.

THIS book is written for manual training classes in schools and colleges, having been prepared in the first instance in manuscript for the students in the College of the City of New York. The manuscript was copied for other schools. Many changes and additions were made under the suggestions of subsequent teaching; and it is now printed and published, for all who desire a volume of the kind. Being the product and result of work in teaching, it could hardly be other than a working book; and a working book, so far as it reveals itself to a critic's ken, it is. Its scope is the presentation of the facts which are most essential to the wood-worker's success and the good execution of his work, and of directions for the use of his tools and for manipulation. These facts and directions are given in a simple, concise style, intelligible to any pupil of ordinary sense. The book deals particularly with carpentry and joinery, and is divided into two parts. The first part treats of the structure, properties, and kinds of wood; its manufactures and economic relations to other substances; parasitic plants and insects, and means of preserving wood; under these heads are articles on the structure and composition of wood, branching of stems, age of trees, their decay, the season for cutting, milling, drying, and warping, the properties and defects of wood, its measure and values, and the kinds of wood. The several species used in wood-work, coarse and fine, are named and described; their value is estimated, their special qualities are pointed out, and the purposes indicated to which they are applied. This is followed by a tabular exhibit of the qualities of the various kinds of wood. A few words are given to the relations of wood and iron, and the wood-working trades are mentioned, and carpentry and joinery defined. A description of parasitic plants or fungi injurious to living trees and lumber follows; an account of injurious insects, prepared expressly for the book by Mr. Bashford Dean, and directions concerning the preservation of wood are given. The second part contains the exercises, preceded by a description of tools. The directions for the care and use of tools are explicit, and are illustrated by drawings representing the method of handling each tool, and the mark it makes. These exercises are followed by those concerning the forming and fixing of the several kinds of joints, gluing, making boxes, with hinging tops, drawers, and generally on uniting several pieces to make a complete structure; a series on the details of ordinary house carpentry, whence models may be constructed and the building of the various parts making up a wooden dwelling learned; the use of the frame-saw and methods of bending wood; pattern-work; shaping (boat model) by the use of templets; and veneering, with directions for painting and polishing.

THE NATIONAL MEDICAL DICTIONARY. Two vols. By JOHN S. BILLINGS, M. D., etc., and Collaborators. Philadelphia: Lea Brothers & Co. Price, $12.

THIS work aims to define "every medical term in current use in English, French, German, and Italian medical literature, including the Latin medical terminology of all of these languages." The pronunciation of English and Latin terms is indicated, and the derivation of most English and Anglicized Latin words (except names of drugs and plants) is given. The dictionary does not attempt to be cyclopedic, but gives simply brief definitions of the words and phrases included in its list. Prefixed to the first volume is a number of tables, including a table of doses, of antidotes, of the inch and metre system, of numbering spectacle-glasses, of thermometric scales, of the average dimensions of the fœtus at different ages, of the average dimensions of the parts and organs of the adult human body, and of the weights of the

organs. Among these tables, also, there is a series, prepared by Prof. W. O. Atwater, showing the percentages of nutrient ingredients in a large number of food-materials, the fuel-values in the same, and standards for dietaries for different classes and occupations. Another table shows the expectation of life as derived from records of life-insurance companies, and from the last United States census.

THE ANATOMY OF THE FROG. By Dr. ALEXANDER ECKER. Translated, etc., by GEORGE HASLAM, M. D. Illustrated. Oxford: Clarendon Press; New York: Macmillan & Co. Pp. 449, with Colored Plates. Price, $5.25.

THE frog is aptly designated by the author as eminently the physiological domestic animal. It is kept in every physiological laboratory, and is daily sacrificed in numbers on the altar of science. The physiologist has recourse to it, not only to obtain answers to new questions, but for the sake of demonstrating easily and quickly the most important known facts of the science. It has furnished the means through which many most important discoveries in physiology have been made. It has "afforded almost the only material for the investigation of the excitability of nerves and its associated electromotive changes, and also no inconsiderable part of the remaining nerve and muscle physiology." Much of our knowledge of the functions of the spinal cord is derived from experiment upon it. Its muscles have served for the investigation of the phenomena and the conditions of contraction. But for the web of its foot and the gills and tail of its tadpole, "we should not perhaps for a long time have arrived at a satisfactory knowledge of the existence and the conditions of the capillary circulation. Acquaintance with the constituents of the blood directly concerned in nutrition; important facts in the physiology of the blood and lymph; and insight into the laws of the heart's action, have all been obtained by observations and experiments on the frog. To it, also, in histology, we owe much of our knowledge of the structure of nerve-fibers, their origin and termination, their relations within the ganglia, and the structure of muscular fiber; and for the study of reproduction and development the frog has, next to the chick, afforded the most important material." The importance of students being well acquainted with the anatomy and structure of an animal which plays so prominent a part in their researches is obvious; and it is this which Dr. Ecker, who is Professor of Human and Comparative Anatomy in the University of Freiberg, and Dr. Haslam, have furnished in the present book. The original work of Prof. Ecker was published in 1864. A second part, embodying, besides the author's work, fruits of the researches of Prof. Wiedersheim, appeared in 1881–'82. The translation was undertaken by Dr. Haslam at the suggestion of Prof. A. Gamgee, and was accepted by the delegates of the Clarendon Press as one of the series of Foreign Biological Memoirs published by them. But it soon became evident that a mere translation would be unsatisfactory, and that it would be desirable to recast and modify parts of the book, and to give descriptions of the minute structure of the several organs. The translator has included the results of recent researches, and has added facts derived from his own observations.

THE ELEMENTS OF ASTRONOMY. WITH AN URANOGRAPHY. By Prof. CHARLES A. YOUNG. Boston: Ginn & Co. Pp. 470. Price, $1.55.

PROF. YOUNG has prepared this text-book for use in high schools and academies, using in it much of the material and many of the illustrations of his larger work, General Astronomy. The author has tried to avoid going to an extreme in cutting down and simplifying, while giving a clear treatment of every subject. From the number of pages in the book it may be inferred that he has provided abundant material for a high-school course in astronomy. He has paid special attention to making all statements correct as far as they go, though many of them, on account of the elementary character of the book, are necessarily incomplete. No mathematics higher than elementary algebra and geometry is introduced into the text. In an appendix of some seventy pages, methods of making certain calculations and the construction of astronomical instruments are described. The Uranography comprises a brief description of the constellations visible in the United States, with four maps, from which the principal stars may be iden-

tified; also a list of such telescopic objects in each constellation as are easily found, and lie within the power of a small telescope. The volume is illustrated with one hundred and fifty-eight cuts.

AMERICAN SPIDERS AND THEIR SPINNING-WORK. Vol. I. By HENRY C. MCCOOK, D. D. Published by the Author: Academy of Natural Sciences, Philadelphia. Pp. 372. Price $30 (set of three volumes).

THE naturalist who takes dried or alcoholic specimens as the subjects of his study can prosecute his researches at all times and seasons, and independently of the will of the creatures that he is studying. But this advantage is offset by the limitation that the habits of the creatures, the kind of places they live in, the sort of structures they make, the way they move about, obtain their food, and rear their young, are a sealed book to him. The observations of the field naturalist, on the other hand, are attended by many more difficulties than those of the laboratory student. He must go to his specimens instead of having them brought to him. Perhaps they are not to be found at all seasons, and, when they are accessible, many hours must be spent in watching familiar actions in order not to miss a chance of seeing a new operation. He has the compensation, however, that he studies the creatures alive; hence the things which are hidden from the laboratory naturalist are revealed to him, and the knowledge that he gains arouses the widest interest and wins the greatest appreciation. The results which Dr. McCook lays before us in the present volume belong mainly in the latter class. They relate to the spinning-work of spiders, as performed in the making of webs and dens. With this is naturally connected some account of the methods of procuring food and the nesting-habits of these creatures, and the intelligence that they display in adapting their operations to particular circumstances. In order to give the reader a correct idea of how spiders form their threads, a fully illustrated chapter on the structure of the spinning-organs has been introduced. The whole work will be confined to the orb-weaving spiders of the United States, but a vast amount of material relating to other tribes, which the author has collected, has been drawn upon in order to make comparisons between the habits of the orb-weavers and other spiders. To the general reader, who sees no important difference between any two common wheel-shaped spider-webs, the distinct varieties of orb-weavers' snares described by Dr. McCook will be a revelation. Artists, too, who are supposed to be careful about the correct shapes of the things they draw, seem to have looked only carelessly at spiders' webs, for our author states that he has never seen but one in art work or book illustrations that gave proof of having been drawn from a natural web, by one who knew its characteristics. In three chapters the general features, the mode of constructing in detail, and the armature of orb-webs are presented. Passing to varieties of the orb, Dr. McCook describes the web with its center of closely woven silk tissue and a zigzag ribbon extending upward and downward, which is made by *Argiope*, a spider whose large size and beautiful markings make it conspicuous in our autumn fields. The round vertical webs made by *Epeïra* and other spiders are then touched upon. An account is given of the composite snares, which consist of a wheel-shaped web combined with a maze of intersecting lines; also of the sectoral orb, in which there is always one division of the wheel that is not crossed by the concentric rings.

Among the other peculiar features in webs that the author describes are the domed orb of the basilica spider, the ribbon decorations of the feather-foot, the triangle or part of a circle constructed by the triangle spider, and the somewhat irregularly radiating snare of the ray spider. A chapter on the engineering skill of spiders gives instances of their using weights to hold their webs taut, their placing of stay-lines in the best position allowed by circumstances, using unfamiliar substances for building a nest, etc. Especially interesting is a chapter on the mechanical strength of webs and the physical power of spiders, in which cases are given of spiders capturing and hoisting from the ground animals many times as large as themselves. Other topics that are fully treated, but which can be only mentioned here, are feeding habits, uses of poison, and nest-making habits. In a concluding chapter on the genesis of snares, the author traces the relations which exist between the various

forms of spinning-work treated in the foregoing pages. The volume contains three hundred and fifty-four illustrations, the author being convinced that a drawing is better to communicate some facts than pages of words. The pictures, moreover, are of artistic quality, and the mechanical work of the volume is of a high grade, making the book a remarkably handsome one. In the second volume of this work the author will treat the habits and industry associated with mating and maternal instincts, life of the young, etc. The third volume will be a systematic presentation of the orb-weavers of the United States, the descriptions being accompanied by a number of lithographic plates colored by hand. The work, aside from its scientific value and its popular interest, will be a treasure to the library of any one who secures a copy. The "author's edition" is limited to two hundred and fifty numbered copies, which are issued in cloth with uncut edges. A large part of the edition had been subscribed for before publication.

The *Report of S. P. Langley, Secretary of the Smithsonian Institution*, for 1889, states that the income of the Smithsonian fund is becoming less and less adequate for the work of the Institution with each year of the country's growth. This fund is now $703,000, of which only $1,500 have been received in bequests since the original Smithson legacy. The secretary calls attention to the Institution as a suitable trustee for moneys intended for the advancement of knowledge. Additional space is needed for exhibition purposes for the National Museum. The appropriation allowed for making the foreign exchanges required by Government does not cover what this service costs the Institution, even though free transportation is given by many steamship companies. The library received 17,354 accessions in the course of the year, and the collection is so large that much of it is inaccessible from lack of room. The collection of living animals, which numbers over three hundred, has outgrown its accommodations, and a scheme for creating a zoölogical park on Rock Creek, in the District of Columbia, is being agitated. The report includes statistics of publications of the Institution during the year, of accessions to the museum and to the library, and of international exchanges.

A great many facts which chemists constantly need to refer to are put into handy shape in the little pamphlet which Prof. *John H. Appleton* has published now for eight years, called the *Laboratory Year-Book* (G. Roscoe and Co., Providence, 12 cents). This publication contains a calendar, notes on the chemical work done in the preceding year, a list of new elements announced since 1877, a table based on the latest revision of atomic and molecular weights, tables of weights, measures, and thermometer scales and equivalents, the C. G. S. system of units, pronunciations of words used in chemistry, logarithms, postal regulations, etc.

The *Meteorological Observations made on the Summit of Pike's Peak, January, 1874, to June, 1888*, are published in the Annals of Harvard College Observatory, Vol. XXII. The observations were made and were prepared for the press by the United States Signal Service, and the expense of publication has been borne by the Boyden fund. The observations occupy four hundred and fifty-eight quarto pages, and are introduced and supplemented by a few pages of text.

The *Observations of the New England Meteorological Society* for 1888, published in the Annals of the Harvard College Observatory, contains tables in which the work of the society for the year is summarized. In a general account of the weather of the year it is stated that nine months were colder and three warmer than the average in New England. The total precipitation exceeded the usual annual fall by twenty-five per cent.

Among the papers that have appeared in recent numbers of *The Modern Science Essayist* (James H. West, Boston; 10 cents a number) is one on The Scope and Principles of the Evolution Philosophy, by Lewis G. Janes, the first lecture of the Brooklyn Ethical Association's second season. Dr. Janes represents evolution as a universal method, explaining the processes of all activity. He states the agnostic position in regard to the Unknowable Cause, and denies that the evolutionist is a materialist. In his closing paragraphs he points out the kind of aid that evolutionary philosophy can give to the solution of the problems of society. The

Moral and Religious Aspects of Herbert Spencer's Philosophy are presented in a paper by Sylvan Drey, under three heads: First, Spencer's theory of religion; second, Spencer's theory of morality; third, the relation of religion to morality from the Spencerian point of view. The object of the essay is exposition and not defense, and the author has the happy faculty of clear statement, which such work requires. In a lecture on Primitive Man, Z. Sidney Sampson sketches the life-record of man as it is revealed to us by the flint implements belonging to the Pleistocene and possibly to earlier geologic periods, by the articles found among the piles in the Swiss lakes, etc. The lecture is devoted mostly to the discoveries and conclusions relating to the earlier Old and New Stone Periods. C. Staniland Wake describes The Growth of the Marriage Relation, giving the attitude of primitive peoples toward consanguineous marriage, some of the varieties of polygyny and of polyandry that have obtained in various countries, and the chief features in the growth of monogamy.

Two successive volumes of the Questions of the Day series are devoted to "the railway problem." One of these, by Hon. *W. D. Dabney*, is entitled *The Public Regulation of Railways* (Putnams, $1.25). It deals with the commercial relations of the railways to the public, and does not take up the regulation of the roads with reference to safety and convenience. The author discusses first the legal aspects of the question and then its economic aspects. Under the former head are considered the sources of legislative power over railroads, and the limitations of this power arising from charter contracts, from the property rights of the owners of railways, and from the powers of Congress over interstate commerce. On these subjects, the decisions of the United States Supreme Court are taken as authority almost exclusively. On the economic side the discussion is based principally upon material contained in the reports and decisions of the Interstate Commerce Commission, and in the testimony and arguments presented to that body in the report made and testimony taken by the "Cullom Committee" of the Senate, and various other reports. The closing chapters contain a brief analysis of the Interstate Commerce Act, and a consideration of the relations of the express companies to the railways and to the people.

The phase of the subject dealt with by Mr. *John M. Bonham* concerns *Railway Secrecy and Trusts* (Putnams, $1.25). The secret discounts that railways make to certain monopolistic manufacturing corporations the author regards as the most serious feature of the railway problem. In his discussion of the subject he traces the growth of abuses in railroad management, showing that they owe their existence to the faulty system under which railroad charters have been granted. He states that the commissions that have been appointed to regulate great trusts and corporations fail to accomplish any reform because they have not the power to get at the secret agreements of these bodies, and he recommends a system of inspection which will prevent the unjust favoritism complained of.

The *Report of the Commissioner of Education for 1887–'88* is about as late in appearing as that of the preceding year, although it was completed three months earlier. The efforts and appeals of Commissioner *Dawson* for prompt publication of this document should meet with better success. Among the topics that receive special attention in the report are the condition and needs of education among the thousand Metlakahtla Indians, who have recently removed from British Columbia to an island near Sitka, also among the other inhabitants of Alaska. Manual training, industrial instruction, and education at the South, are also carefully reviewed.

A course of lectures on the *Constitutional History of the United States, as seen in the Development of American Law* (Putnams, $2), delivered at the University of Michigan, has been published in book form. The subjects and lecturers are as follows: The Federal Supreme Court: its Place in the American Constitutional System, by Judge Thomas M. Cooley; Constitutional Development in the United States as influenced by Chief-Justice Marshall, by Hon. Henry Hitchcock; as influenced by Chief-Justice Taney, by Hon. George W. Biddle; as influenced by the Decisions of the Supreme Court since 1865, by Prof. Charles A. Kent; and The State Judiciary

its Place in the American Constitutional System, by Hon. Daniel H. Chamberlain.

The treatise on *Money*, by *James Platt* (Putnams, 75 cents), is historical, commercial, and economic in scope. It gives a sketch of the origin of money, after which the question, What is money? is discussed. The author defines money as "a commodity, of the same general nature as all other commodities." But he says that, although a wealth in itself, its utility consists in its ready convertibility. Paper is not money, according to his view. Considerable space is devoted to explanations and counsel about banking. Exchange and interest receive attention, and the author then proceeds to discuss wealth and capital. Some considerations on panics are given, with the aim of preventing the tight grip on money that always aggravates a panic. In the closing sections, means of attaining individual success and national prosperity are pointed out.

The History of Federal and State Aid to Higher Education in the United States has been prepared by *Frank W. Blackmar*, Ph. D., at the request of the Bureau of Education, as one of the series upon the history of higher education in the United States, authorized by the Secretary of the Interior. It is intended to represent the progress of the State idea in education from the foundation of the colonies to the present time. It discusses the rise of national education, with its relation to local, and brings forward the opinions of statesmen and scholars concerning the duties and functions of government in public education. A brief history is given of the methods adopted by Congress to encourage and assist institutions of learning, while the main body of the work is devoted to the presentation in a condensed form of the plans pursued by the Legislatures of thirty-eight States in the treatment of higher education. One of the strongest inferences drawn by Commissioner Dawson from the investigation is that in nearly every instance the foremost desire of the people has been for colleges and universities rather than for schools of a lower grade, the opinion having prevailed that primary and secondary schools were dependent for their existence on higher institutions.

The *Twenty-seventh Annual Report of the Massachusetts Agricultural College* gives an account of the work of the institution during 1889, with the usual information about course of study, professors, equipment, etc. Appended to this report is a paper by Prof. Paul Wagner, of Darmstadt, On the most Profitable Use of Commercial Manures, translated by Prof. Charles Wellington in answer to the demand for information on the subject.

In *The Evolution of a Life* (Holt Publishing Company, $2), *Henry Truro Bray* tells the story of his early life, of his career as a clergyman in the Methodist and then in the Episcopal Church, and of his being forced to leave the ministry on account of his growing disbelief in the supernatural doctrines of religion and his increasing disgust with the practices of church-members and men in holy orders. The experiences and incidents which are told in this volume under the veil of fictitious names exhibit many of the persons with whom Mr. Bray's labors brought him in contact in no very enviable light. The story, especially the part relating to the author's married life, reveals the joys and sorrows, hopes and fears, discouragements and triumphs of an affectionate, sensitive, and religious nature, which has been sadly torn by contact with the world.

Bulletin No. 7 of the *Iowa Agricultural Experiment Station* contains accounts of experiments and observations on seven subjects. The chief article is on varieties of corn, and is illustrated with four plates. The other topics treated are the millets, sugar from sorghum, the codling moth, new *Cynipidæ*, the hog-louse, and varieties of grapes.

The *Monthly Bulletin of the Iowa State Board of Health* (Des Moines, 25 cents a year) is a decidedly practical and wide-awake document. Each number is made up of brief and timely articles on hygienic subjects, replies to questions, reports of mortality, and of the appearance of contagious diseases within the State, etc. A Signal Corps meteorological report for each month is also included.

A brief account of *Massage and the Original Swedish Movements* has been prepared for physicians and others interested by *Kurre W. Ostrom* (Blakiston, 75 cents). It describes the operations of massage, with figures, and the various passive movements belonging to the Swedish system. Lists of

manipulations and movements suitable for a large number of diseases are given. In these applications Ling's and Mezger's systems have generally been followed. Some considerations in regard to the effects of exercise are included in the volume, and a caution against the untrained "rubbers" who form a large part of those who claim to be *masseurs* in America, or who use the name as a cloak for vice.

PUBLICATIONS RECEIVED.

Alabama. Agricultural Experiment Station. Microscopical Study of Certain Varieties of Corn. By P. H. Mell. Pp. 16, with Plate.

American Chemical Society, Journal, March, 1890. Monthly. New York: John Polhemus. Pp. 24. $5 a year.

Barkan, Louis, M. D. How to preserve Health. New York: Exchange Printing Company. Pp. 344.

Bashkirtseff, Marie. The Journal of a Young Artist. New York: Cassell Publishing Company. Pp. 434. 50 cents.

Bean, Tarleton H. Description of a New Cottoid Fish. Pp. 2.

Blackmar, Frank W. The History of Federal and State Aid to Higher Education in the United States. Washington: Government Printing-Office. Pp. 343.

Boole, Mary. Logic taught by Love. Boston: Alfred Mudge & Son. Pp. 177.

Brinton, Daniel G. Essays of an Americanist. Philadelphia: Porter & Coates. Pp. 489. $3.

Brinton, Daniel G., and Jastrow, Morris, Jr. The Cradle of the Semites. Pp. 26.

Canfield, William B., M. D. Three Papers on Pulmonary Phthisis and Pneumonia. Pp. 10.—Some Complications of Chronic Endarteritis. Pp. 10.—The Early Detection of Pulmonary Consumption. Pp. 11. Baltimore.

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POPULAR MISCELLANY.

Jacob Ennis.—This able but retiring man was born in Essex County, N. J., in 1807. He came of sturdy Scotch-Irish stock on his father's side, and was of Dutch extraction (the Doremuses) on his mother's side. After graduating at Rutgers College, and when yet quite a young man, he connected himself with the Dutch Reformed Church, and was by that organization sent to the islands of Java and Sumatra as a missionary, where he remained four years. Here his powers of observation and his love for the study of nature had an early development. Returning to his native country, he soon engaged in educational work, and was elected Professor of Natural Sciences in the National Military College of Bristol, Pa. Afterward he became principal and proprietor of the Scientific and Classical Institute of Philadelphia, where he spent the best part of his life. He also occupied for some years the chair of Physical Sciences in the State Normal School at Shippenburg, Pa. In his career as an educator, he from the start laid great stress on the importance of the study of nature, and was indeed a bold and fearless innovator in this respect, anticipating by perhaps a quarter of a century the recognition that scientific studies have subsequently had in all the highest institutions of learning. His life was quiet, simple, dignified, but laborious. He was a member of the chief scientific bodies both in this country and abroad, and his contributions in the shape of addresses before learned societies, pamphlets, and articles in scientific periodicals were many and varied, always strikingly original, often profound, and sometimes prophetic. Among these contributions, chiefly on astronomical problems, was one entitled The Two Great Works to be done on our Sidereal Systems. In this publication two questions are asked—First: Which way round does the great ring of the milky way revolve? Second: In which direction must we look for the center of our sidereal systems, and how far is it distant? These two questions he attempted to answer himself in an unpublished work, upon which he expended all the time and thought that he could command during the latter days of his life. He considered this the most important and certainly the most original and far-reaching of his works on astronomy, and it will no doubt be published in due time. In his book on The Origin of the Stars, published over twenty years ago, some of the most transcendental problems of physical astronomy were attacked and solved with a keen analysis, an abundance of facts, and a wealth of illustration worthy of a master of the science. Prof. Ennis's intellectual scope and sympathies were not narrow or one-sided; he was familiar with the entire range of English and classical literature, and was an excellent linguist. His literary style was simple, direct, and lucid; he had a great dislike for "big words," and always succeeded in making his ideas clear by the use of plain and untechnical language even when handling the most abstruse problems. His habits and tastes were simple, his wants few, his disposition kindly and gentle, and the attitude of his mind was distinctly reverent. He was so quiet, mod-

est, and unobtrusive that but few suspected the presence of a great thinker so near at home, and fewer still knew him personally. He died in Houston, Texas, January 12, 1890.

The Late Henry James Clark.—A biography and bibliography of Henry James Clark has been published by the Massachusetts Agricultural College, in which he was the first professor. He was born in 1826, began the study of botany under Asa Gray in 1850, and became a pupil and private assistant of Agassiz, who spoke of him in 1857 as "the most accurate observer in the country." He was in succession adjunct Professor of Zoölogy in Harvard University; Professor of Botany, Zoölogy, and Geology in the Agricultural College of Pennsylvania; Professor of Natural History in the University of Kentucky; and Professor of Comparative Anatomy and Veterinary Science in the Massachusetts Agricultural College; and he was a member, fellow, or correspondent of the principal American scientific societies, including the Academy of Sciences when its membership was limited to fifty. He assisted Agassiz in the preparation of parts of the Contributions to the Natural History of the United States; delivered lectures on histology and the Cambridge Museum of Comparative Zoölogy; and delivered a course of lectures at the Lowell Institute on Mind in Nature; or the Origin of Life, and the Mode of Development of Animals. He died on the first day of July, 1873, in the forty-eighth year of his age. The list of his scientific writings comprises twenty-seven titles, mos of which cover more than one article.

Educational Value of Manual Training.—The committee report of the National Council of Education on the Educational Value of Manual Training admits the reasonableness of substituting a system of manual training in special schools, in so far as it can be done, for the old system of apprenticeship, but insists that the training ought not to be begun before the completion of the pupil's twelfth year, nor before he has had the statutory instruction prescribed by the state in the intellectual branches of school work. It admits that manual training is an educative influence, and that, in so far as the schools teach the scientific principles that underlie the practical points of their work, they add intellectual education to physical education. The study of general scientific principles, according to Dr. William T. Harris's interpretation of the views of the report, would be educative in the first rank: they explain all machines and all natural phenomena in our present experience, and will explain those that we meet in the future. In the second rank are special applications of science in the form of theories of special machines, as, for example, of the steam-engine. These theories explain all machines made in accordance with them; they are very general, but not so general as the scientific theories of the forces involved. They are accordingly less educative. A third and least educative school exercise is the construction of a particular machine, when the theory is narrowed down to a special example. The laborer meets many new things in the work of constructing the machine, but unhappily they are not educative, because they are contingent, and do not assist in explaining or constructing the next machine. Examined in these three grades of educative value, the purely manual work of the school belongs to the lowest grade, and furnishes the obscurest knowledge of principles covered up by a mass of non-essential circumstances. The committee, however, lays stress on the importance of æsthetic culture through drawing. It is culture in taste that American workmen need, and not culture in skill, for our laborers are already ingenious and skillful and industrious. Drawing is the best means of acquiring familiarity with the conventional forms of beauty in ornament—forms that express the outlines of freedom and gracefulness, and charm all peoples, even those who have not the skill to produce them; and make markets for the articles that bear them.

Causes of Insanity.—The latest report of the British Commissioners of Lunacy gives tables showing the causes of insanity as verified by the medical officers of the institutions, in the cases of 136,478 patients who have been admitted into public and private asylums since 1887. The causes are classified as "moral" and "physical." As might

be expected, "intemperance in drink" heads the list of single causes, with 18,290 cases. Of "moral causes," "domestic trouble," "adverse circumstances," and "mental anxiety and worry, and overwork," are collectively held responsible for 25,897 cases. Of other moral causes, "religious excitement" is credited with 3,769 cases, "love affairs" with 2,224, and "fright and nervous shock" with 1,953. Of physical causes, "sexual diseases" are credited with 3,447 cases, "overexertion" with 761, "sunstroke" with 1,686, "accident or injury" with 4,199, "diseases of women" with 11,315, "old age" with 5,773, "privation and starvation" with 2,607, "fevers" with 880, "puberty" with 582, and "other bodily diseases or disorders" with 14,719. Previous attacks had occurred in 22,703 cases. Hereditary influence was ascertained in 28,063, and congenital defect in 5,881. As between the sexes, 66,918 were of the male and 69,560 of the female sex.

Rights on Other Men's Lands.—A paper by Mr. Hyde Clarke, on "The Rights of Property in Trees" on the land of another, relates to a curious custom of primeval times which still survives in some lands. The author first met it as a land judge in Asia Minor in 1862, when he was called upon to grant compensation for olive-trees belonging to one or more persons on the lands of others, and for honey-trees or hoards of wild honey in state or communal forests. Papers read by the Rev. Dr. Codington gave information of the existence of a like system in Melanesia. It likewise prevails, according to Mr. Crocker, of the British North Borneo Company, in Borneo, in respect to the *katapang*, or honey-tree, and also in the case of caves containing edible bird's-nests. Sir Spencer St. John also observes that in Borneo the land nominally belongs to the state or tribe, but the ownership is not a private property in land in our sense of the word. He had observed that certain of the *tapang*, on which the bees construct their nests, often belonged to special families, and were not touched by their neighbors. Sir Thomas Wade has found a similar right in China, where, when hill farms or gardens are leased, the tenant will pay the proprietor a yearly rent. All fir-trees or bamboos on the ground before it is let belong to the proprietors, and the tenant is not free to appropriate them. If there were no such trees on the ground when it was let, and such trees were subsequently planted by the tenant, they would be at his disposal. Separate property in trees is also traceable in India, particularly in Chota Nagpore, where Mr. J. F. Hewitt has frequently found that fruit trees growing on land are owned by persons other than the owners or cultivators of the soil. The *mhowa*-trees, which are exceedingly valuable, are frequently divided among the inhabitants of the villages near which they grow. This individual property in trees is not in Turkey confined to Asia Minor, but prevails as a general law in the empire. Miss Pauline Inby found it in Bosnia, and bought an interest of the kind in a certain estate. It seems also to have anciently existed in the British Islands, and is recognized in the Brehon records of Ireland. But there, and in most European countries, the vestiges of the separate rights have ceased to exist.

Soaping Geysers.—It has been often observed that throwing soap into the geysers of the Yellowstone Park will produce or hasten an outburst. The phenomenon has been investigated by Prof. Arnold Hague, of the United States Geological Survey, who finds that two conditions are essential to the production of an eruption in this way: first, the surface caldron or reservoir should hold but a small amount of water, exposing only a limited area to the atmosphere; and, second, that the water should stand at or above the boiling-point of water for the altitude of the geyser basin above sea-level. The latter is the principal factor. Many of the geysers and hot springs present the singular phenomena of pools of water heated above the theoretical boiling-point, and, unless disturbed, frequently remain so for many days without exhibiting any signs of ebullition. Thermal waters in this condition may be made to boil by other artificial means that will disturb their equilibrium, as by casting sinter into them, and, in one instance at least, by a strong temporary gust of wind. If soap or lye is thrown into most of the small pools, a viscous fluid is formed; and viscosity is, in

the opinion of the author, the principal cause in hastening geyser-action. It tends to cause the steam to be retained within the basin, and, when the temperature stands at or above the boiling-point, explosive liberation must follow. All alkaline solutions exhibit, by reason of this viscosity, a tendency to bump and boil irregularly. Viscosity in the hot springs must also tend to the formation of bubbles and foam when the steam rises to the surface, and this in turn aids to bring about the explosive action, followed by a relief of pressure, and thus to hasten the final and more powerful display. The practice of casting in soap is regarded as detrimental to the preservation of the geysers, and as a proper object of restriction.

The Nature of Poisoned Arrows.—The word poison, as applied to the poisoned arrows used in the Solomon Islands, Santa Cruz, the Banks Islands, and the New Hebrides, should be understood, according to the Rev. Dr. R. H. Codington, in a peculiar sense. The practice of administering poison in food was common among the natives, but it was doubtful whether what was used had much power of doing harm. The deadly effect was expected to follow from the incantations with which the poison was prepared. In the same way the deadly quality of the poisoned arrows was never thought by the natives to be due to poison in our sense of the word, though what was used might be, and was meant to be, injurious and active in inflaming the wound. It was the supernatural power that belonged to the human bone of which the arrow-head was made on which they chiefly relied, and with that the magical power of the incantations with which it was fastened to the shaft. The bone of any dead man will give efficacy in the native belief to the arrow, because any ghost may have power to work on the wounded man; but the bone of one who was powerful when alive is more valued. In Lepers' Island, a young man, out of affection for his dead brother, took up his bones and made them into arrows. He carried these about him, and did not speak of himself as "I," but as "we two"—his brother and himself—and he was much feared; all the supernatural power of the dead brother was with the living. Although it is the human bone that gives the deadly quality to the arrow, the bone must be prepared with certain incantations which add supernatural power. The poison is an addition to the power of the bone. The native did not much consider, if at all, the natural power to hurt, of either bone or poison. A dead man's bone made the wound, the power of the ghost was brought by incantation to the arrow, and therefore the wounded man would die. Euphorbia-juice is hot and inflaming; it is smeared on the bone with an incantation which calls in the power of a dead man's ghost; when the wound is given, the ghost will make it inflame. The cure of the wounded man is conducted on the same principle. If the arrow-head, or a part of it, can be recovered, it is kept in a damp place or on cool leaves; the inflammation of the wound is little, or subsides. Shells are kept rattling over the house where the man lies, to keep off the hostile ghost. In the same way the enemy who has inflicted the wound, and his friends, will drink hot and burning juices, and chew irritating leaves; pungent and bitter herbs will be burned to make an irritating smoke, and will be tied upon the bow that sent the arrow; the arrow-head, if recovered, will be put into the fire. The bow will be kept near the fire, and its string kept taut and occasionally pulled, to bring on tension of the nerves and the spasms of tetanus. Prof. Victor Horsley has suggested that the value of the human bone tipping the arrow was first made evident by the employment of a bone from a corpse recently dead, in the decomposing tissues of which the septicæmic virus would consequently be flourishing.

The Mesozoic Atlantic Coast Region.—In his address before the Geological Section of the American Association, Prof. Charles E. White, defining the Mesozoic formations of North America, said that the rocks of the Triassic age are found from Prince Edward Island to the Carolinas. They rest on formations, from the Archæan to the Carboniferous, inclusive. Very few invertebrate fossils have been found in the Trias of the Atlantic coast region, and these are of little value for indicating the age of the strata that contained them. Intermediate between the Triassic beds and the undisputed Cretaceous deposits of this region is a series of

strata of littoral and estuary origin, to which the name Potomac formation has been applied. These deposits are only a few hundred feet thick, and, though frequently covered from sight, seem to be continuous from New Jersey to Mississippi. Invertebrate fossils are rare, but large collections of fossil plants have been found in the Potomac region. The best authorities recognize several of these fossils as Jurassic. Briefly, then, the Mesozoic of the Atlantic coast region consists of a probable representation of the Upper Trias of Europe, a possible one of the Upper Jura, a probable slight one of the Middle Cretaceous, and a practically certain representation of a large part of the Upper Cretaceous, with a hiatus between the latter and the Eocene. The speaker advocated a system of classification more suited to this country than the European one. The time has come when North American geologists can and ought to hold a commanding position in this matter.

Olives and their Oil.—The olive has been cultivated in the regions of the Mediterranean coasts from time immemorial. Olive-oil there takes the place of butter. Spain has about 3,000,000 acres in olives, Italy 2,250,000, and France about 330,000 acres. Forty-five varieties of the fruit are described. The tree occasionally grows to be sixty feet high, and twelve feet in circumference of trunk. The varieties differ in the nature of the wood, the foliage, and the quality and shape of the fruit. The fruit is mild, or sharp, or bitter; and the oils differ likewise; so that a pure olive-oil may be unfit for purposes of food, and only fit for greasing machinery and making soap. The green, unripe olives, having had the bitter taste extracted with salt, are preserved in vinegar with spices. The ripe olives are gathered in the fall, when they are as large as common plums. They are of dark-green color, and the pit, now become a hard stone, contains a savory kernel. The flesh is spongy, and its little cells are filled with the mild oil, which runs out at the least pressure. The finest oil is the virgin oil which is made by collecting the freshly gathered olives in little heaps, and letting them press the oil out by their own weight. It is clear, and has a delicate, nutty taste, with little or no odor. When the fruits cease to give the oil by themselves, they are pressed with small millstones, yielding an oil which is also clear and has a pleasant taste. The olives, still rich in oil, are next put in sacks, boiling water is poured over them, and they are pressed once more. The oil gained by this process is yellowish-green, and has a sharp taste and an unpleasant smell. At Marseilles the olive-oils are classed into manufacturing oils for burning, greasing machinery, and soap-making; refined oil; oil from the pulp or husks, and table or edible oil. The last is superfine, fine, half fine, and ordinary. The table oil is refined by allowing it to run through layers of thin sheets of wadding into tin perforated boxes. The wadding absorbs all the thick particles, and leaves the oil clear and tasteless. The olive crop is variable and uncertain, and is seldom profitable more than once in six or eight years.

Avogadro.—According to a sketch published by Prof. Hugo Schiff, of Florence, in the "Chemiker Zeitung," Amadeo Count Avogadro, son of the magistrate Filippo Vercellone, was born in Turin, August 9, 1776. He studied jurisprudence at the Turin University, became Doctor of Laws on March 16, 1796, and then held a position under the Government till 1806, when he began his scientific career. In physics he was self-taught, and obtained a subordinate position in the Collegio delle Provincie in Turin, which was then and still is a richly endowed department of the Turin University. On November 7, 1809, he became Professor of Physics at the Gymnasium in Vercelli. In 1820 he was elected Professor of Mathematical Physics at the Turin University. Later this chair of instruction was abolished, and Avogadro resumed the practice of law. He was, however, reinstated in his chair through the influence of Charles Albert, and remained at the university till 1850, when he retired on account of old age and ill health. He died at Turin, July 9, 1856, at the age of eighty years. Avogadro was but little known in Italy and unknown in foreign countries. He shared with Charles Gerhard, who died in the same year, August 19, 1856, the same fate. It was only after death that their great and important contributions to science found recognition.

Atmospheric Nitrogen as Food for Plants.—The results of experiments at the agricultural stations at Middletown and Mansfield, Conn., are in favor of the value of atmospheric nitrogen as a food for plants. The conclusions are deduced from them by Prof. Atwater that many, if not most, of the leguminous plants are able to and do acquire large quantities of nitrogen from the air during their period of growth; and that there is some connection, not yet defined, between root-tubercles and the acquisition of this aliment. The cereals with which experiments have been completed have not manifested the same power, and they do not have such tubercles as are formed on the roots of the legumes. The addition of soil infusions did not seem necessary for the production of root-tubercles. The size and vigor of the plants, and their gain of nitrogen from the air, seemed to be proportional to the abundance of root-tubercles in the experiment. Losses of nitrogen sometimes occurred, but always in cases where there were no root-tubercles. The ability of legumes to gather nitrogen from the air helps to explain the usefulness of certain members of the family as renovating crops, and enforces the importance of using them to restore fertility to exhausted soils. Conversely, the loss of nitrogen suffered by some other crops, such as oats, suggests a possible reason why they should appear to be "exhausting" crops.

Coffee in Brazil.—The cultivation of coffee has been greatly extended in Brazil during recent years, chiefly in the southern provinces. The planting is done on freshly cleared ground after a single crop of Indian corn has been raised from it, either by sowing the seed directly or often by transplanting from slips grown in nursery rows. During the earlier years corn, beans, and occasionally sugar-corn are grown between the rows. The coffee-plant usually begins to bear at the fourth year from the nursery, or the fifth or sixth year from the seed. The tree is supposed to reach its prime at ten years old, becomes practically sterile at twenty, and may by care be kept in bearing for forty years. The extremes of the flowering season are from August to January. The berry begins to form in November, and to ripen in April or May, when the harvesting begins. This is done by hand, and generally very carelessly. The berries are washed, dried, and put through various processes of cleaning for the market; what is called "washed" coffee is put through a different process, in which much of the treatment is given under water.

Object-Studies in Botany.—Prof. Bessey some time ago urged teachers of botany to give a more intelligent direction to the collections which their pupils will make during the season of study. The usual course is to gather a surplus of the showy flowers which are the most easily studied, and neglect the others, of which less is known. The teacher should take special pains to point out the features of interest in the funguses, etc., which the student may bring in. Let him direct attention to the pores, on the walls of which the spores are developed — to the closely interwoven threads of the body of the fungus. When a spotted strawberry-leaf is brought in, let him tell something, if it be but little, about the cause of the spots; and let the pupil be taught to look for similar spots on other plants, and to study them. Do so with lichens, with pond-scums, with green slimes, with mosses, with liverworts—in fact, with whatever is brought in by the sharp-eyed young collector. "He must be a poor teacher indeed who can not suggest something to his pupil about a toad-stool or a puff-ball. It is not necessary to know the species or even the genus to which a plant has been assigned in order to be able to make valuable suggestions to one's pupils."

Contributions to the Geology of Staten Island.—Dr. N. L. Britton has reported to the Natural Science Association of Staten Island concerning observations that lead him to consider that the serpentine and talcose rocks forming the main ridge of the island were derived from magnesian limestone and hornblende or tremolite strata. The rocks were doubtless originally deposited in a conformable sequence, but the serpentines were left on top in the folding of the strata. The hypothesis of a southwestward extension of the crystalline rocks across New Jersey has been confirmed in a well-boring at Perth Amboy. Considerable additions to the fossil

flora have been obtained by Mr. Hallick from the ferruginous sandstone on the shore at Tottenville. The occurrence of copper, derived from the decomposition of pyrites, in the limonite ore beds at Todt Hill is mentioned. Several well-defined nearly driftless areas north and west of the terminal moraine illustrate an interesting feature of glaciation.

NOTES.

Prof. D. S. Martin's Geological Map of New York City and its Environs is the only map giving in detail the geology of the entire region (fifty-five by sixty-eight miles) surrounding the metropolis; it is compiled with great care from separate sources, some of which are not easily accessible, and some are unpublished; it exhibits the relations of many geological systems and series east of the Alleghanies; and shows striking features connected with the Glacial age, the terminal moraine, and the ancient (now submerged) channel of the Hudson River. A pamphlet of explanations accompanies every copy. A few copies of the second edition of the map still reman for disposal at ten dollars each. No more are likely to be published. Address Prof. Martin, at Rutgers Female College, West Fifty-fifth Street, New York.

Mr. C. R. Orcutt remarks, in the West American Scientist, on the prominence of the great variety in rock-lichens in producing a pleasing effect in the scenery of Lower California. Red, yellow, gray, and white are the prevailing colors, and the whole side of a cliff is often covered by lichens of the same tint. Quartz, however, is not a favorite rock with the lichens, and consequently is seldom concealed. The lichens frequently imitate, in coloring, the natural hue of the rocks on which they are found.

A book by Mr. George F. Kunz, the distinguished mineralogical expert of the house of Tiffany & Co., on the Gems and Precious Stones of North America, is announced for publication by the Scientific Publishing Company, New York. It will be a popular description of the occurrence, value, history, and archæology of precious stones in America, and of the collections in which they exist, with a chapter on pearls. The several species and varieties are described systematically. The work will be sold at ten dollars a copy.

Mr. John Griffitt, of Smyrna, has reported favorably on the results of a season's experiments in rearing silk-worms on mulberry-trees, under muslin screens, in the open air, using the regenerated Bournabat *graine*. They show that the regeneration was thorough and complete, enabling the worms to endure the low temperature of 45° F., with storm and wet for ten consecutive days. The proportion of *satiné* or satin-like cocoons was extraordinary—fifty to two hundred and ninety-four in all. A somewhat similar trial made in India some years ago was successful experimentally but not financially. In this case the worms, under calico screens, ate along the hedge at their will, new relays taking the place of the old ones as the parts of the hedge over which they had eaten recovered their leaves.

River water was substituted for spring water in one of the quarters of Paris several times last summer. In every instance, according to the "Semaine Médicale," an increase of typhoid fever was observed. The quantity of spring water brought to Paris being insufficient for the demand, the Council of Public Hygiene and Health has determined to expedite the labors for the new supply from springs recently bought by the city, and to insist that the use of the present spring waters be limited to food purposes.

Henry Holt & Co. will publish soon, Introduction to Systematic Botany. By Charles E. Bessey, professor in the University of Nebraska, and author of Bessey's Botanies in the American Science Series.

M. de Malarce recently informed the French Academy of Sciences that the use of the metric system had in 1887 become compulsory in countries having an aggregate population of 302,000,000, being an increase of 53,000,000 persons obliged to use it in ten years; use was optional in countries having nearly 97,000,000 inhabitants; and was legally admitted and partially applied in countries having an aggregate population of 395,000,000. The systems of Japan, China, and Mexico are decimal but not metric. Hence the metric system is legally recognized by 794,000,000 people and decimal systems by about 474,000,000 others.

By the Hungarian trade law of 1884, every commune in which there are fifty or more apprentices must provide for their education, and afford special courses of instruction. The apprentice schools in Buda-Pesth contain a preparatory class, provide a course of three years, and are chiefly designed to educate apprentices for the higher trade schools. Each district of the town must have at least one apprentice school. No class is to have more than fifty or at most sixty pupils. Deserving pupils are promoted at the end of each year. In the other towns and counties of the kingdom there are 229 apprentice schools, with 1,237 teachers and 38,081 pupils.

The Swedish Oyster-culture Society is trying to acclimatize American oysters from Connecticut on the coast of the province of Bahus. The young oysters seem to thrive well.

A SCHEME of the French Government to encourage the intermarriage of life-convicts in New Caledonia with life-convicts imported from the prisons at home is pronounced mischievous by the "Lancet." The purpose is to build up family relations in the interest of morality; but British experience is to the effect that such alliances lead to the multiplication of criminals, and that the real check to crime lies in breaking up and isolating the criminal class. Testimony gleaned by M. Louis Barron from the journals of New Caledonia points in the same direction, and forms an instructive commentary on the law of heredity as deduced by Darwin.

THE French fishermen are troubled by the depredations of porpoises, for which they have not succeeded in finding a remedy. An attempt was made to catch them in seine nets, but they jumped out of the snares. They were scared away by guns and torpedoes, but the fish were frightened and disappeared with them. They are too numerous to be shot one by one in an effective manner. The only thing to be done seems to be for the fishermen to unite and drive them away in crowds; but this will have to be often repeated. Insurance and payment of damages by the Government are the last measures of relief suggested; but they, too, are expensive to somebody.

VANILLA is produced from a species of orchid that attaches itself to walls, trees, and other suitable objects. The plant has a long, fleshy stem, and the leaves are alternate, oval, and lanceolate. The flower is of a greenish-white color, and forms axillary spikes. The fruit is a pod, measuring when full grown some ten or twelve inches in length and about half an inch in diameter. The quality of the pod can be determined by the presence or non-presence of a crystalline efflorescence called *givre*, and by its dark chocolate-brown color. The fragrant *givre* is *vanillin*, $C_8H_8O_3$. The pods also contain vanillic acid, oily matter, soft resin, sugar, gum, and oxalate of lime.

A STRIKING example of degeneration in growth is exhibited by the scale that attacks greenhouse and other plants. According to Mr. Bernard Thomas, in "Science Gossip," it is a degenerated female which lives upon the sap of the plant, continuing to increase in size and reproduce its young. These may be found underneath it as minute red bodies, just visible to the naked eye, and at this time of their life comparatively active creatures; but they soon settle down and begin to degenerate. Their eyes become indistinct, and finally, with their antennæ and legs, shrivel away, the body loses its thickness, and they appear as if without life.

TOTEMS are defined by Mr. J. G. Fraser as "a class of material objects which a savage regards with superstitious respect, believing that there exists between him and every member of the class an intimate and altogether special relation." They are tribal emblems, family symbols, signals of nationality, expressions of religion, bonds of union, and regulators of marriage-laws and of the social institutions. The system of totems exists among most primitive peoples, and in similar forms with the North American Indians, Australians, South Africans, Arabs, hill tribes of India, Polynesians, and many other peoples. Among a tribe in Colombia, where descent is in the female line, it goes so far that if a man happens to cut himself with his own knife, to fall off from his own horse, or to hurt himself in any way, his mother's clan demand blood-money from him for injuring one of their totems.

OBITUARY NOTES.

PROF. VAN QUENSTEDT, of Tübingen, one of the most famous of German paleontologists, died December 21st, at an advanced age. He was the author of a work on the Jura, and of a Handbook of Petrefactenkunde, or the science of petrifactions. He had an especially profound knowledge of the Lias of Würtemberg and its fossils.

M. CH. FIEVEZ, assistant in the spectroscopic department of the Royal Observatory of Brussels, died February 2d, aged forty-five years. He studied first for the military profession, but was invited to the observatory by M. Houzeau, and entered it after studying under Janssen at Meudon. His most important work was the construction of a chart of the solar spectrum on a larger scale than that of Angström. He made a detailed study of the spectrum of carbon, and experiments on the behavior of spectral lines under the influence of magnetism and of changes of temperature.

DR. C. C. PARRY, a distinguished American botanist, recently died at Davenport, Iowa, aged sixty-seven years. He made valuable collections of plants, and was an authority in the classification of the North American flora. He was for several years a botanist in the Agricultural Department in Washington. Mount Parry, near Denver, was named after him.

PROF. RICHARD OWEN, geologist, died from accidental poisoning at his home in New Harmony, Ind., March 24th. He was a son of the Scotch philanthropist, Robert Owen, and was born in Scotland, January 6, 1810. Having been schooled in Europe and come to the United States, he studied civil engineering in Kentucky, was a Professor of Geology there, served in the United States Survey, was a captain in the Mexican War, was State Geologist for Indiana, professor in Indiana State University, and lieutenant-colonel and colonel in Indiana volunteer regiments.

THEODORE SCHWANN.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

VIII. THE ANTIQUITY OF MAN AND EGYPTOLOGY.

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IN the great ranges of investigation which bear most directly upon the origin of man, there are two in which Science within the last few years has gained final victories.

The significance of these in changing, and ultimately in reversing, one of the greatest currents of theological thought, can hardly be overestimated; not even the tide set in motion by Cusa, Copernicus, and Galileo was so powerful to bring in a new epoch of belief.

The first of these conquests relates to the antiquity of man on the earth.

The fathers of the early Christian Church, receiving all parts of our sacred books as equally inspired, laid little, if any, less stress on the myths, legends, genealogies, and tribal, family, and personal traditions contained in the Old Testament, than upon the most lofty poems, the most instructive apologues, and the most powerful utterances of prophets, psalmists, and apostles. As to the life of man upon our planet, by bringing together indications of elapsing time in the various books of the Bible, early Christian commentators arrived at conclusions varying somewhat, but in the main agreeing. Some, like Origen, Eusebius, Lactantius, Clement of Alexandria, and the great fathers generally of the first three centuries, dwelling especially upon the Septuagint version of the Scriptures, thought that man's creation took place about six thousand years before the Christian era. Strong confirmation of this view was found in a simple piece of

purely theological reasoning: for, just as the seven candlesticks of the Apocalypse were long held to prove the existence of seven planets revolving about the earth, so it was felt that the six days of creation prefigured six thousand years during which the earth in its first form was to endure; and that, as the first Adam came on the sixth day, Christ, the second Adam, had come at the sixth millennial period. Theophilus, Bishop of Antioch, in the second century, clinched this argument with the text, "One day is with the Lord as a thousand years"; hence the view of the early Church, that the world was then in its last period, and that the seventh day—the great millennium—would arrive about the year 1000 of our era. What striking consequences this belief finally produced all scholars of mediæval history know well.

On the other hand, Eusebius and St. Jerome, dwelling more especially upon the Hebrew text, which we are brought up to revere, thought that man's origin took place at a somewhat shorter period before the Christian era; and St. Jerome's overwhelming authority made this the dominant view throughout western Europe during fifteen centuries.

The simplicity of these great fathers as regards chronology is especially reflected from the tables of Eusebius. In these, Moses, Joshua, and Bacchus—Deborah, Orpheus, and the Amazons—Abimelech, the Sphinx, and Œdipus, appear together as personages equally real, and their positions in chronology equally ascertained.

At times great bitterness was aroused between those holding the longer and the shorter chronology, but, after all, the difference between them, as we now see, was trivial; and it may be broadly stated that in the early Church, "always, and everywhere, and by all," it was held as certain, upon the absolute warrant of Scripture, that man was created from four to six thousand years before the Christian era.

To doubt this, and even much less than this, was to risk damnation. St. Augustine insisted that belief in the antipodes and in the longer duration of the earth than six thousand years were deadly heresies, equally hostile to Scripture. Philastrius, the friend of St. Ambrose and St. Augustine, whose fearful catalogue of heresies served as a guide to intolerance throughout the middle ages, condemned with the same holy horror those who expressed doubt as to the orthodox number of years since the beginning of the world, and those who doubted an earthquake to be the literal voice of an angry God, or who questioned the plurality of the heavens, or who gainsaid the statement that God brings out the stars from His treasures and hangs them up in the solid firmament above the earth every night.

About the beginning of the seventh century, Isidore of Seville,

the great theologian of his time, took up the subject. He accepted the dominant view, not only of Hebrew but of all other chronology, without anything like real criticism; the childlike faith and simplicity of his system may be imagined from his summaries which follow. He tells us:

"Joseph lived one hundred and five years. Greece began to cultivate grain.

"The Jews were in slavery in Egypt one hundred and forty-four years. Atlas discovered astrology.

"Joshua ruled for twenty-seven years. Ericthonius yoked horses together.

"Othniel, forty years. Cadmus introduced letters into Greece.

"Deborah, forty years. Apollo discovered the art of medicine and invented the cithara.

"Gideon, forty years. Mercury invented the lyre and gave it to Orpheus."

Reasoning in this general way, Isidore kept well under the longer date; and the great theological authority of southern Europe having thus spoken, the question was virtually at rest throughout Christendom for nearly a hundred years.

Early in the eighth century the Venerable Bede, the great theological authority of the North, took up the problem. Dwelling especially upon the received Hebrew text of the Old Testament, he soon entangled himself in very serious difficulties; but, in spite of the great fathers of the first three centuries, he reduced the antiquity of man on the earth by nearly a thousand years, and, in spite of mutterings against him as coming dangerously near a limit which made the theological argument from six days to six ages look doubtful, his authority had great weight, and did much to fix western Europe in its allegiance to the general system laid down by Eusebius and Jerome.

In the twelfth century this belief was re-enforced by a tide of thought from a very different quarter. Rabbi Moses Maimonides and other Jewish scholars, by careful study of the Hebrew text, arrived at conclusions diminishing the antiquity of man still further, and thus gave strength to the shorter chronology throughout the middle ages: it was incorporated into the sacred science of Christianity; and Vincent de Beauvais, in his great Speculum Historiale, forming part of that still more enormous work which sums up all the knowledge possessed by the ages of faith, placed the creation of man at about four thousand years before our era.*

* For the date of man's creation as given by leading chronologists in various branches of the Church, see L'Art de Vérifier les Dates, Paris, 1819, vol. i, pp. 27 *et seq.* In this edition there are sundry typographical errors; compare with Wallace, True Age of the World, London, 1844. As to preference for the longer computation by the fathers of the Church, see Clinton, Fasti Hellenici, vol. ii, p. 291. For the sacred significance of the six days of

At the Reformation this view was not disturbed. The same manner of accepting the sacred text which led Luther, Melanchthon, and the great Protestant leaders generally, to oppose the Copernican theory, fixed them firmly in this biblical chronology; the key-note was sounded for them by Luther when he said, "We know, on the authority of Moses, that longer ago than six thousand years the world did not exist." Melanchthon, more exact, fixed the creation of man at 3963 B. C.

But the great Christian scholars continued the old endeavor to make the time of man's origin more precise; there seems to have been a sort of fascination in the subject which developed a long array of chronologists, all weighing the minutest indications in our sacred books, until the Protestant divine, De Vignolles, who had given forty years to the study of biblical chronology, declared that he had gathered no less than two hundred computations based upon Scripture, and no two alike.

As to the Roman Church, about 1580 there was published, by authority of Pope Gregory XIII, the Roman Martyrology, and this, both as originally published and as revised in 1640 under Pope Urban VIII, declared that the creation of man took place 5199 years before Christ.

But of all who gave themselves up to these chronological studies, the man who exerted the most powerful influence upon the dominant nations of Christendom was Archbishop Usher. In 1650 he published his Annals of the Ancient and New Testaments, and it at once became the greatest authority for all English-speaking peoples. Usher was a man of deep and wide theological learning, powerful in controversy; and his careful conclusion, after years of the most profound study of the Hebrew Scriptures, was, that man was created 4004 years before the Christian era. His verdict was widely received as final; his dates were inserted in the margins of the authorized version of the English Bible, and were soon practically regarded as equally inspired with the sacred text itself; to question them seriously was to risk preferment in the Church and reputation in the world at large.

The same adhesion to the Hebrew Scriptures which had influenced Usher, brought leading men of the older Church to the same view; men who would have burned each other at the stake for

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creation in ascertaining the antiquity of man, see especially Eicken, Geschichte der mittelalterlichen Weltanschauung; also Wallace, True Age of the World, pp. 2, 3. For the views of St. Augustine, see Topinard, Anthropologie, citing the De Civ. Dei., lib. xvi, c. viii, lib. xii, c. x. For the views of Philastrius, see the De Hæresibus, c. 102, 112, *et passim*, in Migne. For Eusebius's simple credulity, see the tables in Palmer's Egyptian Chronicles, vol. ii, pp. 828, 829. For Bede, see Usher's Chronologia Sacra, cited in Wallace, True Age of the World, p. 35. For Isidore of Seville, see Isidore, Etymologia, lib. v, c. 39; also lib. iii, 617.

their differences on other points, agreed on this: Melanchthon and Tostatus, Lightfoot and Jansen, Salmeron and Scaliger, Petavius and Kepler, inquisitors and reformers, Jesuits and Jansenists, priests and rabbis, stood together in the belief that the creation of man was proved by Scripture to have taken place between 3900 and 4004 years before Christ.

In spite of the severe pressure of this line of authorities, extending from St. Jerome and Eusebius to Usher and Petavius, all in favor of this scriptural chronology, even devoted Christian scholars, had sometimes felt obliged to revolt. The first great source of difficulty was increased knowledge regarding the Egyptian monuments. As far back as the last years of the sixteenth century, Joseph Scaliger had done what he could to lay the foundations of a more scientific treatment of chronology, insisting especially that the historical indications in Persia, in Babylon, and, above all, in Egypt, should be brought to bear on the question. More than that, he had the boldness to urge that the chronological indications of the Hebrew Scriptures should be fully and critically discussed in the light of Egyptian and other records, without any undue bias from theological considerations. His idea may well be called inspired, yet it had little effect as regards a true view of the antiquity of man, even upon himself, for the theological bias prevailed above all his reasonings, even in his own mind. Well does a brilliant modern writer declare that, "among the multitude of strong men in modern times abdicating their reason at the command of their prejudices, Joseph Scaliger is perhaps the most striking example."

Early in the following century Sir Walter Raleigh, in his History of the World (1603–1616), pointed out the danger of adhering to the old system. He, too, foresaw one of the results of modern investigation, stating it in these words, which have the ring of prophetic inspiration: "For in Abraham's time all the then known parts of the world were developed. . . . Egypt had many magnificent cities, . . . and these not built with sticks, but of hewn stone, . . . which magnificence needed a parent of more antiquity than these other men have supposed." In view of these considerations, Raleigh followed the chronology of the Septuagint version, which enabled him to give to the human race a few more years than were usually allowed.

About the middle of the seventeenth century Isaac Vossius, one of the most eminent scholars of Christendom, attempted to bring the prevailing belief into closer accordance with ascertained facts, but save by a chosen few his efforts were rejected. In some parts of Europe a man was by no means safe from bodily harm in holding new views on chronology. As an example of the extreme pressure exerted by the old theological system at times

upon honest scholars, we may take the case of La Peyrère, who, about the middle of the seventeenth century, put forth his book on the Pre-Adamites—an attempt to reconcile sundry well-known difficulties in Scripture by claiming that man existed on earth before the time of Adam. He was taken in hand at once; great theologians rushed forward to attack him from all parts of Europe; within fifty years thirty-six different refutations of his arguments had appeared; the Parliament of Paris burned the book, and the Grand Vicar of the archdiocese of Mechlin threw him into prison and kept him there until he was forced, not only to retract his statements, but to abjure his Protestantism.

But, in spite of warnings like this, we see the new idea cropping out in various parts of Europe. In 1672 Sir John Marsham published a work in which he showed himself bold and honest. After describing the heathen sources of Oriental history, he turns to the Christian writers, and, having used the history of Egypt to show that the great Church authorities were not exact, he ends one important argument with the following words: "Thus the most interesting antiquities of Egypt have been involved in the deepest obscurity by the very interpreters of her chronology, who have jumbled everything up (*qui omnia susque deque permiscuerunt*), so as to make them match with their own reckonings of Hebrew chronology: truly a very bad example, and quite unworthy of religious writers."

This sturdy protest of Sir John against the dominant system and against the "jumbling" by which Eusebius had endeavored to cut down ancient chronology within safe and sound orthodox limits, had little effect. Though eminent chronologists of the eighteenth century, like Jackson, Hales, and Drummond, gave forth multitudes of ponderous volumes pleading for a period somewhat longer than that generally allowed, and insisting that the received Hebrew text was grossly vitiated as regards chronology, even this poor favor was refused them; the great mass of believers found it more comfortable to hold fast the faith committed to them by Usher, and it remained settled that man was created about four thousand years before our era.

This tide of theological reasoning rolled on through the eighteenth century, swollen by the biblical researches of leading commentators, Catholic and Protestant, until it came in great majesty and force into our own nineteenth century; and it was well received. At the very beginning of our century it gained new strength from various great men in the Church, among whom may be especially named Dr. Adam Clarke, who declared that, "to preclude the possibility of a mistake, the unerring Spirit of God directed Moses in the selection of his facts and the ascertaining of his dates."

All opposition to the received view seemed broken down; and as late as 1835, indeed as late as 1850, came an announcement in the work of one of the most eminent Egyptologists, Sir J. G. Wilkinson, to the effect that he had modified the results he had obtained from Egyptian monuments, in order that his chronology might not interfere with the received date of the Deluge of Noah.*

But all investigators were not so docile as Wilkinson, and there soon came a new train of scientific thought which rapidly undermined all this theological chronology. Not to speak of other noted men, we have early in the present century Young, Champollion, and Rosellini, beginning a new epoch in the study of the Egyptian monuments. Nothing could be more cautious than their procedure, but the evidence was soon overwhelming in favor of a vastly longer existence of man in the Nile Valley than could be made to agree with even the longest duration then allowed by theologians.

First of all, in spite of all the suppleness of men like Wilkinson, it became evident that, whatever system of scriptural chronology was adopted, Egypt was the seat of a flourishing civilization at a period before the "Flood of Noah," and that no such flood had ever interrupted it. This was bad, but worse remained behind: it was soon clear that the civilization of Egypt began earlier than the time assigned for the creation of man, even according to the most liberal of the sacred chronologists.

As time went on, this became more and more evident: the long duration assigned to human civilization in the fragments of Manetho, the Egyptian scribe at Thebes in the third century B. C., was discovered to be more accordant with truth than the chronologies of the great theologians; and, as the present century has gone on, scientific results have been reached absolutely fatal to the chronological view based by the universal Church upon Scripture for nearly two thousand years.

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* For Lightfoot, see his Prolegomena relating to the age of the world at the birth of Christ; see also in the edition of his works, London, 1822, vol. iv, pp. 64, 112. For Scaliger, see the De Emendatione Temporum, 1583; also Mark Pattison, Essays, Oxford, 1889, vol. i, pp. 162 *et seq.* For Raleigh's misgivings, see his History of the World, London, 1614, p. 227, Book II of Part I, section 7 of chapter i; also Clinton's Fasti Hellenici, ii, 293. For Usher, see his Annales Vet. et Nov. Test., London, 1650. For Marsham, see his Canon Chronicus Aegyptiacus Ebraicus Graecus et Disquisitiones, London, 1672. For La Peyrère, see especially Quatrefages, in Revue des Deux Mondes for 1861, as cited in Topinard, Anthropologie, p. 52. For Jackson, Hales, and others, see Wallace's True Age of the World. For Wilkinson, see various editions of his work on Egypt. For Vignolles, see Leblois, vol. iii, p. 617. As to the declarations in favor of the recent origin of man, sanctioned by Popes Gregory XIII and Urban VIII, see Strauchius, cited in Wallace, p. 97. For the general agreement of church authorities, as stated, see L'Art de Vérifier les Dates, as above. As to difficulties of scriptural chronology, see Ewald, History of Israel, English translation, London, 1883, pp. 204 *et seq.*

As is well known, the first of the Egyptian kings of whom mention is made upon the monuments of the Nile Valley is Mena, or Menes. Manetho had given a statement, according to which Mena must have lived nearly six thousand years before the Christian era; this was looked upon for a long time as utterly inadmissible, since it was so clearly at variance with the chronology of our own sacred books; but, as time went on, large fragments of the original work of Manetho were more carefully studied and distinguished from corrupt transcriptions, the lists of kings at Karnak, Sacquarah, and the two temples at Abydos were brought to light, and the lists of court architects were discovered. Among all these monuments the scholar who visits Egypt is most impressed by the sculptured tablets giving the lists of kings. Each shows the monarch of the period doing homage to the long line of his ancestors. Each of these sculptured monarchs has near him a tablet bearing his name. That great care was always taken to keep these imposing records correct is certain; the loyalty of subjects, the devotion of priests, and the family pride of kings were all combined in this, and how effective this care was is seen in the fact that kings now known to be usurpers are carefully omitted. The lists of court architects, extending over the period from Seti to Darius, throw a flood of light over the other records.

Comparing, then, all these sources, and applying an average from the lengths of the long series of well-known reigns to the reigns preceding, the most careful and cautious scholars have satisfied themselves that the original fragments of Manetho represent the work of a man honest and well informed, and, after making all allowances for discrepancies and the overlapping of reigns, it has become clear that the period known as the reign of Mena must be fixed at about five thousand years B. C. In this the three great Egyptologists of our time concur; Mariette, the eminent French authority, puts the date at 5004 B. C., and with this the foremost English authority, Sayce, agrees; Brugsch, the leading German authority, puts it at about 4500 B. C. We have it, then, as the result of a century of work by the most acute and trained Egyptologists, and with the inscriptions upon the temples and papyri before them, both of which are now read with as much facility as many mediæval manuscripts, that the reign of Mena must be placed close upon seven thousand years ago.

But the significance of this conclusion can not be fully understood until we bring into connection with it some other facts revealed by the Egyptian monuments.

The first of these is that which struck Sir Walter Raleigh—that, even in the time of the first dynasties in the Nile Valley, a high civilization had already been developed. Take, first, man

himself: we find sculptured upon the early monuments types of the various races—Egyptians, Israelites, negroes, and Libyans—as clearly distinguishable in these paintings and sculptures of from four to six thousand years ago as the same types are at the present day. No one can look at these sculptures upon the Egyptian monuments, or even the fac-similes of them, as given by Lepsius or Prisse d'Avennes, without being convinced that they indicate, even at that remote period, a difference of races so great that long previous ages must have been required to produce it.

Take, next, the social condition of Egypt revealed in these early monuments of art: they force us to the same conclusion. Those earliest monuments show that a very complex society had even then been developed. We not only have a separation between the priestly and military orders, but agriculturists, manufacturers, and traders, with a whole series of subdivisions in each of these classes. The early tombs show us sculptured and painted representations of a daily life which even then had been developed into a vast wealth and variety of grades, forms, and usages.

Take, next, the political and military condition: one fact out of many reveals a policy which must have been the result of long experience. Just as now, at the end of the nineteenth century, the British Government, having found that they can not rely upon the native Egyptians for the protection of the country, are drilling the negroes from the interior of Africa as soldiers, so the celebrated inscription of Prince Una, as far back as the sixth dynasty, speaks of the Maksi or negroes levied and drilled by tens of thousands for the Egyptian army.

Take, next, engineering: here we find very early operations in the way of canals, dikes, and great public edifices, so bold in conception and thorough in execution as to fill our greatest engineers of these days with astonishment. The quarrying, conveyance, cutting, jointing, and polishing of the enormous blocks in the interior of the Great Pyramid alone are the marvel of the foremost stone-workers of our century.

As regards architecture, we find not only the pyramids, which date from the very earliest period of Egyptian history, and which are to this hour the wonder of the world for size, for boldness, for exactness, and for skillful contrivance, but also the temples with long ranges of colossal columns wrought in polished granite, with wonderful beauty of ornamentation, with architraves and roofs vast in size and exquisite in adjustment, which by their proportions tax the imagination, and lead the beholder to ask whether all this can be real.

As to sculpture, we have not only the great Sphinx of Gizeh, so wonderful by its boldness and plastic character, dating from

the very first period of Egyptian history, but we have ranges of sphinxes, heroic statues, and bas-reliefs, showing that even in the early ages this branch of art had reached an amazing development.

As regards the perfection of these, Lübke, the most eminent German authority on plastic art, referring to the early works in the tombs about Memphis, declares that, "as monuments of the period of the fourth dynasty, they are an evidence of the high perfection to which the sculpture of the Egyptians had attained." Brugsch declares that "every artistic production of those early days, whether picture, writing, or sculpture, bears the stamp of the highest perfection in art." Maspero, the most eminent French authority in this field, while expressing his belief that the Sphinx was sculptured even before the time of Mena, declares that "the art which conceived and carved this prodigious statue was a finished art, an art which had attained self-mastery and was sure of its effects"; and Sir James Fergusson, the highest English authority, declares, "We are startled to find Egyptian art nearly as perfect in the oldest periods as in any of the later."

The evidence as to the high development of Egyptian sculpture in the earlier dynasties becomes every day more overwhelming. What exquisite genius the early Egyptian sculptors showed in their lesser statues is known to those who have seen those most precious specimens in the Boulak Museum at Cairo, which were wrought before the conventional type was adopted in obedience to religious considerations.

Take, next, decorative and especially ceramic art: as early as the fourth and fifth dynasties we have vases, cups, and other vessels showing exquisite beauty of outline and a general sense of form equal to Etruscan and Grecian work of the best periods.

Take, next, astronomy: to say nothing of the other evidences of a long development of thought in this field, we may go back to the very earliest period of Egyptian civilization, and we find that the four sides of the Great Pyramid are adjusted to the cardinal points with the utmost precision. "The day of the equinox can be taken by observing the sun set across the face of the pyramid, and the neighboring Arabs adjust their astronomical dates by its shadow."

The same view is confirmed by philologists. To use words of Max Düncker: "The oldest monuments of Egypt, and they are the oldest monuments in the world, exhibit the Egyptian in possession of the art of writing." It is found also by the inscriptions of the early dynasties that the Egyptian language had even at that early time been developed in all essential particulars to the highest point it ever attained. What long periods it must have required for such a development every scholar in philology can imagine.

As regards medical science, we have the Berlin papyrus, which, although of a later period, refers with careful specification to a medical literature of the first dynasty.

So, too, as regards archæology: the earliest known inscriptions point to still earlier events and buildings, indicating a long sequence of previous events.

And, finally, as to all that pertains to the history of civilization, no man of fair and open mind can go into the museums of Boulak or the Louvre or the British Museum and look at the monuments of those earlier dynasties without seeing in them the results of a development in art, science, laws, customs, and language, which must have required a vast period before the time of Mena for their development. And this conclusion is forced upon us all the more invincibly when we consider the slow growth of ideas in the earlier stages of civilization as compared with the later—a slowness of growth which has kept the natives in many parts of the world in that earliest civilization to this hour. To this we must add the fact that Egyptian civilization was especially immobile; its development into castes is but one among many evidences that it was the very opposite of a civilization developed rapidly.

As to the length of the period before the time of Mena, there is, of course, nothing exact. Manetho gives lists of great personages before that first dynasty extending over twenty-four thousand years. Bunsen, one of the most learned of Christian scholars, declares that not less than ten thousand years were necessary for the development of civilization up to the point where we find it in Mena's time. No one can claim precision for either of these statements, but they are valuable as showing the impression of vast antiquity made upon the most competent judges by the careful study of those remains. No unbiased judge can doubt that an immensely long period of years must have been required for the development of civilization up to the state in which we there find it.

The investigations in the bed of the Nile confirm these views. That some unwarranted conclusions have at times been announced is true; but the fact remains that again and again rude pottery and other evidences of early stages of civilization have been found in borings at places so distant from each other, and at depths so great, that for such a range of concurring facts, considered in connection with the rate of earthy deposit by the Nile, there is no adequate explanation save the existence of man in that valley thousands on thousands of years before the longest time admitted by our sacred chronologists.

Nor have these investigations been of a careless character. Between the years 1851 and 1854, Mr. Horner, an extremely cautious

English geologist, sank ninety-six shafts in four rows at intervals of eight English miles, at right angles to the Nile, in the neighborhood of Memphis. From these pottery was brought up from various depths, and beneath the statue of Rameses II at Memphis at a depth of thirty-nine feet. At the rate of the Nile deposit a careful estimate has declared this to indicate a period of over eleven thousand years. As eminent a German authority in geography as Peschel characterizes objections to such deductions as groundless. However this may be, the general results of these investigations, taken in connection with the other results of research, are most convincing.

And, finally, as if to make assurance doubly sure, a series of archæologists of the highest standing, French, German, English, and American, have within the past twenty years discovered relics of a savage period, of vastly earlier date than the time of Mena, prevailing throughout Egypt. These relics have been discovered in various parts of the country, from Cairo to Luxor, in great numbers. They are the same sort of prehistoric implements which prove to us the early existence of man in so many other parts of the world at a geological period so remote that the figures given by our sacred chronologists are but trivial. The last and most convincing of these discoveries, that of flint implements in the drift, far down below the tombs of early kings at Thebes, will be referred to later. What such discoveries prove, we shall consider in the next chapter.*

* As to Manetho, see for a very full account of his relations to other chronologists, Palmer, "Egyptian Chronicles," vol. i, chap. ii. For a more recent and readable account, see Brugsch, Egypt under the Pharaohs, English edition, London, 1879, chap. iv. For lists of kings at Abydos and elsewhere, also the lists of architects, see Brugsch, Palmer, Mariette, and others; also illustrations in Lepsius. For the various race types given on early monuments, see the colored engravings in Lepsius, Denkmäler; also Prisse d'Avennes, and the frontispiece in the English edition of Brugsch; see also statement regarding the same subject in Tylor, Anthropology, chap. i. For the fullness of development in Egyptian civilization in the earliest dynasties, see Rawlinson's Egypt, London, 1881, chap. xiii; also Brugsch and other works cited. For the perfection of Egyptian engineering, I rely not merely upon my own observation, but on what is far more important, the testimony of my friend the Hon. J. G. Batterson, probably the largest and most experienced worker in granite in the United States, who acknowledges, from personal observation, that the early Egyptian work is, in boldness and perfection, far beyond anything known since, and a source of perpetual wonder to him. As to the perfection of Egyptian architecture, see very striking statements in Fergusson, History of Architecture, Book I, chap. i. As to the pyramids, showing a very high grade of culture already reached under the earliest dynasties, see Lübke, "Ges. der Arch.," Book I. As to sculpture, see for representations photographs published by the Boulak Museum, and such works as the Description de l'Égypte, Lepsius's Denkmäler, and Prisse d'Avennes; see also as a most valuable small work, easy of access, Maspero, Archæology, translated by Miss A. B. Edwards, New York and London, 1887, chaps. i and ii. See especially in Prisse, vol. ii, the statue of Chafrê the Scribe, and the group of "Tea" and his wife. As to the artistic value of the Sphinx, see Maspero, as above, pp. 202, 203. See also similar ideas in Lübke's History of Sculpt-

GLASS-MAKING.

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IV.—IN THE ATELIER OF A GLASS-WORKER.

THERE are few objects of manufacture which better than glass illustrate the immense preponderance in value of human labor over crude material. It is a substance which might serve economists as a parallel to their favorite illustration of the comparative values of a steel watch-spring and the bit of iron-bearing earth from which it is wrought.

In the case of glass, the crude materials are so plentifully distributed in nature as to be almost valueless. The basis of the compound, sand, is so very abundant that it has furnished the symbol, in more than one parable, for quantity without limit. Like the unnumbered sands of the sea was a vast promise to the children of men. Somewhat less abundant than the sand are the other chemicals which it is necessary to mix with it in order to produce that double silicate which goes under the general name of glass. They are, however, far from being either scarce or expensive. The alkaline ingredient, the carbonate of soda, is made from common salt, a mineral whose wide distribution in nature is at once apparent when one recalls the fact that the sea, thirty or forty times in bulk the total elevated mass of the earth, is one vast storehouse of the substance; that salt springs or brines abound at our very doors—in New York State, in Michigan, and in Virginia; and that vast deposits of the solid rock-salt are to be found in Louisiana and Prussia. The third ingredient, the lime, is simply calcined limestone, a rock which forms whole ranges of hills, and is found in every corner of the globe. For the production of the fine flint glass, or crystal, which forms the special subject of the glass-worker's skill, it is also necessary to add a fourth ingredient, red lead or minium. As this is the oxide of an easily

ure, vol. i, p. 24. As to astronomical knowledge evidenced by the Great Pyramid, see Tylor, as above, p. 21. For delineations of vases, etc., showing Grecian proportion and beauty of form under the fourth and fifth dynasties, see Prisse, vol. ii, Art Industriel. As to the philological question, and the development of language in Egypt, with the hieroglyphic system of writing, see Rawlinson's Egypt, London, 1881, chap. xiii; also Le Normant; also Max Düncker, Geschichte des Alterthums, Abbot's translation, 1877. As to the medical papyrus of Berlin, see Brugsch, vol. i, p. 58, but especially the Papyrus Ebers. As to the corruption of later copies of Manetho and fidelity of originals as attested by the monuments, see Brugsch, chap. iv. As to the accuracy of the present Egyptian chronology as regards long periods, see ibid., vol. i, chap. xxxii. As to the pottery found deep in the Nile and the value of Horner's discovery, see Peschel, Races of Man, New York, 1876, pp. 42–44. For succinct statement, see also Laing, Problems of the Future, p. 94.

reducible and useful metal, it is naturally considerably more expensive than the earthy ingredients, but its cost is still far within the limits of moderation. The Rocky Mountains and the Mississippi Valley furnish lead ores in such abundance that the compounds of the metal may fairly be classed among cheap products.

The total cost of the "batch" can not be more than a few cents a pound. Compare this with the value of the finished products. The finer cut glass will sell for perhaps as many dollars a pound, while the finest cameo glass may bring almost as many hundred. It must not be supposed, however, that the difference, or even the

FIG. 1.—THE GLASS-CUTTER AT HIS WHEEL.

greater part of it, goes into the pocket of the manufacturer. A fair proportion reaches that destination, but by far the larger share goes for meat and bread and coal, houses and cloth, to sustain the life of the army of men, women, and children by whose labor these dull earths and oxides are transformed into the brilliant carafes and bowls which adorn our dinner-tables.

Much the greater part of this increased value is conferred upon the glass by the dexterous hand-work expended in the atelier, rather than by the coarser operations which attend the furnace process. This, however, is the basis of all that follows, and the beginnings of the finest cut-glass bowl or cameo vase are to be sought in the mixing-room, where the crude materials are put together. In different establishments the proportions vary, as in the manufacture of all other forms of glass products, and even in the same establishment uniformity is far from absolute.

Although glass is supposed to be a fairly definite chemical compound, each manufacturer has his own notions on the subject, and occasionally he changes his mind, or perhaps his supplies come from a different locality. The result, in either case, would be a slight change in the composition of the batch. A typical mixture would be for every hundred parts of fine white sand about forty parts of alkali (carbonate of soda), ten parts of burned lime, and forty parts of red lead.

It will be noticed that the batch is essentially different from that used in the manufacture of window and of bottle glass. It differs both in the character and the quality of the materials employed. The ingredients common to the several mixtures must be much purer for use in the production of table and household glassware of the finer grades. Care is taken that the sand shall contain no iron; and, in order to free it from any admixture of loam or other disadvantageous earthy materials, it is subjected to a washing process before it is brought to the mixing-room. By this treatment the more finely divided matter, such as clay and the like, is carried off with the water, while the coarser sand settles to the bottom of the washing-troughs. Further, in the selection of the alkali, the cheaper sulphate of soda is never substituted for the carbonate, as is frequently done in the manufacture of bottles.

In the processes of the atelier the competition is a question of quality rather than of quantity. The element of human labor is so large that it would not be economical to expend it upon an inferior grade of glass. The workers, or rather the men who direct them, go on the principle of those wise domestic economists who reflect that the cost of labor in making up clothing is approximately constant, and who therefore do not feel that they can afford to buy shoddy.

The earthy materials—sand, alkali, and lime—give substance and transparency. Fused together, they form ordinary glass. The additional ingredient, the red lead, has a special function to perform It has for its immediate object an increase in the weight of the glass; and since in general an increase in weight means an increase in refracting power, its ultimate object is an additional brilliancy in the product. Every one has noticed the heaviness of cut glass; or, if he has not, and enters a shop to buy a piece of it, the shop-keeper is very apt to call his attention to the fact—particularly if the price be correspondingly heavy—assuming that weight is an undeniable guarantee of quality and brilliancy. If you object to the price, he puts the piece into your hands and says confidingly, "Just feel the weight of it!" The argument is a pertinent one, but not altogether conclusive, for there are many other elements besides weight upon which the merit of the product depends. It is quite possible to have the glass too heavy for

beauty, since the dense lead compounds have a tendency to separate from the lighter silicates, and, consequently, if present in too large amounts, they make the glass streaky and mottled. In general, lead glass for domestic uses has a specific gravity of from three to four—that is, it is from three to four times as heavy as an equal bulk of water. The brilliancy given to the glass by its increased density has attached the name crystal to this particular product.

It is essential that the several ingredients should be thoroughly mixed, and to this end the operation is carried out mechanically. The materials are fed into the upper end of a slowly revolving hopper, whose axis is slightly inclined to the horizontal, and are thoroughly mixed by the time they reach the discharging end. A dainty pink powder falls into the receiving bins. Its subsequent baptism by fire transforms the opaque into the transparent. The furnaces employed for this purpose are of the type common to other glass-melting processes—simply a circular and intensely heated chamber, surmounted by a stack, and provided with radial openings to permit the blowers to dip their blowpipes into the molten contents of the fire-clay crucible-pots.

FIG. 2.—THE PROCESS OF ENGRAVING ON GLASS.

The scene around this industrial caldron is quite as busy as that which has its center in the bottle furnace, and is even more varied. The workers are fashioning objects of the most diverse shape and for the most unlike purposes. Some are blowing lamp-chimneys, others gaslight globes, or decanters or dishes. In the center of the apartment a large press, with engraved steel dies, is squeezing the plastic "metal"—for so the glass-blower designates his still fluid glass—into decorative panels for car-windows and transoms. As one passes from one end of the large room to the other, he will see almost every conceivable shape in glass, suited

for table or other domestic usage, taking form in the hands of the adroit workers. It is the scene of an intense and a highly ingenious activity. The bottles and dishes and globes intended for subsequent treatment in the atelier are all blown, the manipulations being varied in accordance with the special form it is desired to produce. As a rule, it may be said that it is cheaper to produce the pressed glass than the blown, since less time is required in fashioning the articles; but for the finer work the blown is always preferred, as glass worked exclusively in the air has a much more brilliant surface than that which has been formed in contact with the faces of the iron mold. The plain articles thus shaped are known in the trade as "blanks." The largest manufacturers of cut and engraved glass also make their own blanks, but there are a number of establishments which confine themselves exclusively to the processes of ornamentation. The articles intended for such decoration go from the blower to the annealing leer, where they are permitted to pass through a chamber of brick-work some sixty to eighty feet long, subjected to a gradually decreasing temperature for a period of twenty-four hours or less, according to the circumstances of the work. The articles to be annealed are placed in wrought-iron cars, and are slowly moved through the leer, coming out perfectly cold.

FIG. 3.—THE OPERATION OF MAKING GROUND GLASS GLOBES.

It is in this way that the blanks are prepared for the atelier proper. Here one finds a number of very interesting operations going on side by side. The untechnical visitor will perhaps be most attracted by the cutting process, since the results are so brilliant, and the articles possess so staple a value. He will get a good insight into the general principles by following the process of cutting a carafe.

The blank itself is perfectly plain—a simple, heavy bottle with smooth surface. Its proportions are good. The decoration is to consist of a twenty-four-pointed star on the bottom, a series of more or less complicated diagonal cuttings on the bulging sides, and six or eight broad facets around the neck. To these may be added a number of features of less prominence, such as a series of oval facets around the base of the carafe, and some smaller cuttings at the top. It is the glass-worker's custom to begin with the star on the bottom. This is cut entirely by the eye, no design being traced on the glass. The first process is known technically as "roughing" it, and consists in cutting the design in the glass with coarse tools, which leave rough facets, but remove most of the glass to be cut away. The roughing-wheel is made of iron, and is about two feet in diameter. It is mounted on a horizonal axis. The face of the wheel is about seven eighths of an inch broad, and is kept supplied with a mixture of coarse sand and water allowed to constantly drip upon it from a hopper above. The wheel makes about a thousand revolutions a minute, the speed varying with the character of the work to be done. It is slower for the deeper cuttings. The workman seizes the carafe with both hands, and presses the bottom firmly against the edge of the rotating wheel, making a cut across the center, and as far each way as it is desired to have the star extend. Then he turns the carafe around one sixth of a revolution, and makes a similar cut through the center, judging of the distance entirely by his eye. A second turn of one sixth of a revolution, and a third cut along a diameter is made. This gives a six-pointed star. The intervening spaces are then divided by similar cuts, and the spaces thus formed again divided, giving a twenty-four-pointed star.

A tyro in the art would make a very poor figure of it, but the regular cutters become exceedingly expert, and are able to make comparatively perfect designs in this seemingly off-hand fashion. A trained eye will, of course, have no difficulty in detecting inaccuracies, but the designs are symmetrical enough for all purposes of decoration.

The cutting does not yet possess much beauty, for its faces are as rough as ground glass. Already, however, it begins to show the promise of what it is to be. In treating the bulging sides of the carafe, greater difficulties present themselves in disposing the pattern symmetrically. It is, therefore, the custom to paint a number of guiding lines on the surface of the glass. A few circular lines surrounding the carafe, and a few up-and-down lines afford a series of intersections which are sufficient to enable the cutter to develop a uniform pattern. In the same way the facets surrounding the neck are determined by a couple of limiting cir-

les, and similarly with the secondary part of the decoration. his completes the rough work.

The second process is that of "smoothing," and is carried out by eans of wheels made of a natural stone found in Scotland, known s the Craig Leigh stone. A large part of modern Edinburgh is uilt out of this material. It is a compact silicious stone, wearing ery uniformly, and almost free from that tendency to crumble hich characterizes the majority of our native sandstones. The tone wheels are about the same size as the iron wheels used in the oughing process; but their cutting edges, instead of being smooth, re beveled, thus giving a sharp edge in the center of the face. his is occasionally harpened by regrinding, or by holding ieces of flint against he beveled faces of he revolving wheel. A tiny stream of wa- er falls constantly gainst the face of the tone. Each cut made on the iron wheel is gone over on the stone, and, by the finer friction, the surface of the facets becomes smooth and transparent. The carafe is slowly becoming an object of beauty.

Fig. 4.—The Sand-Blast in Operation.

Next in the order of the processes comes the polishing, which is effected by wooden wheels mounted as before and supplied with pumice or rotten-stone. Red willow is considered the best material for the polishing-wheel, though poplar is also frequently used. The hard woods are found to be less suitable for the purpose. The wooding—for so this third process is called in the atelier—gives a fine finish to the smoothed facets and adds greatly to their brilliancy. It is a process, however, which is only practicable in cases where the cutting is rather deep. Where it amounts to little more than a tracing, the wooden wheel would be of slight use.

Still a fourth process is required before the carafe is ready to

be washed and placed on sale. It is that of brushing. The brush is made of spun glass, and is applied in the form of a wheel as a burnisher. Those who have seen gilt used in china-painting will recall the pencils of spun glass with which the gilding is burnished after being fired. The rapidly revolving brush of glass cleans out the cuttings more perfectly than could be done in any other way, and adds the final luster to the facets. The carafe is now completed. Other articles are cut in much the same way, slight modifications being made to suit different shapes and patterns.

At the present time very good copies of cut-glass articles are made in pressed goods, and at about one twentieth of the cost; but the difference between the two products can readily be detected. Not only are the pressed goods less brilliant, but the edges of their facets are visibly rounded from the fusion, and fail to give the sharp, clear faces of the genuine cut glass. One can tell the fine article at once by simply rubbing his finger over the cutting. The sharp edges of the genuine article are unmistakable. Another attempt to combine beauty and economy is made by cutting some prominent feature of a pressed-glass article, and letting the brilliancy thus obtained make amends for the duller facets of the less exposed portions. In this way pressed-glass decanters are made quite presentable by being supplied with well-cut stoppers, and covered dishes pass muster through the merit of their brilliant knobs. Still another device is that of grinding off the faces of pressed-glass goods, and thus securing, as the result of a much cheaper process, the sharp edges and well-polished faces of the real cut glass. The process, however, is not a very successful one. It sounds better than it works out in practice. Wares treated in this way have the serious defect of lacking brilliancy when compared to the air-blown glass and entire cutting. They are now made in but small quantity, for they can not compete in public estimation with the ordinary pressed goods, since they cost about five times as much, and are far from being five times as effective.

In the most artistic circles there is at present a slight reaction against cut glass in favor of the light and graceful articles made in blown glass. But meanwhile the sale of cut glass grows larger each year, for the improvements in the method of production bring it within reach of an increasingly wide circle of buyers. It promises to remain a standard article of manufacture, for its brilliancy will always attract admirers, and any disappearance will be but temporary. The old-fashioned chandeliers and candelabra, made with pendants of cut glass, are pushed out of the market by newer metallic goods, only to periodically reappear from their obscurity.

Alongside of the cutter's wheel one sees a corner of the atelier devoted to a species of cutting in miniature, which goes under the name of engraving. The cutting instrument is a small copper disk, sometimes as tiny as a dentist's tool, and sometimes several inches in diameter. It is mounted with its axis horizontal, and is made to rotate very rapidly. The cutting is done under-

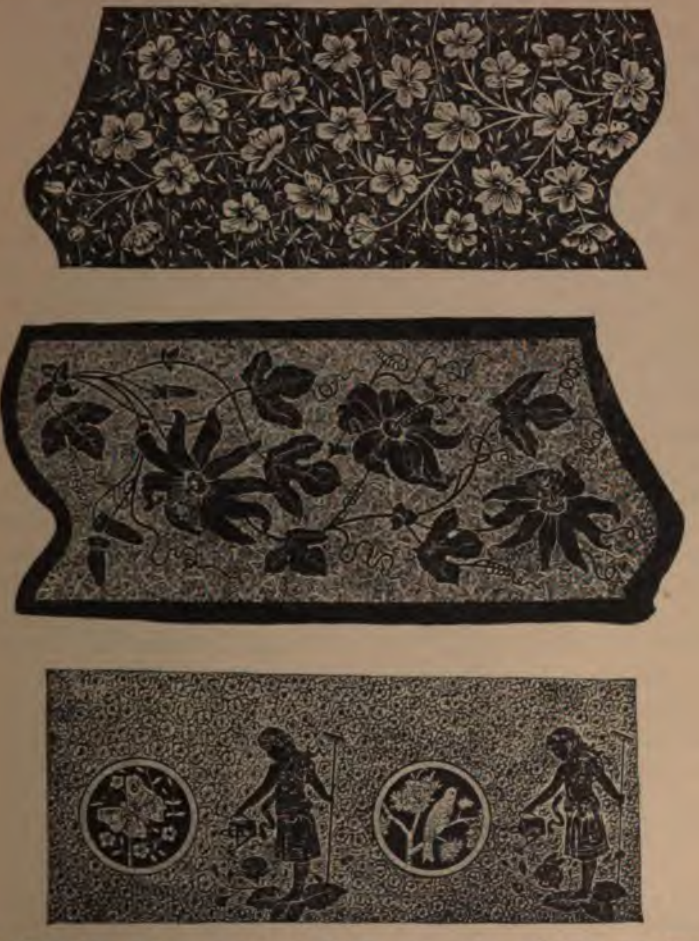

FIG. 5.—THE PRINTED DESIGNS, READY FOR TRANSFERENCE TO THE GLASS, IN THE ETCHING PROCESS.

hand, instead of overhand, as in the former operation, which means, in the language of the outside world, that the article to be engraved is brought into contact with the rotating disk from beneath, instead of being pressed against its upper surface. The disk is supplied with a mixture of emery and oil. This is the real cutting agent; the disk simply applies it. In almost all cases the work is done solely by the eye, without any guiding lines what-

ever. Frequently the engraver originates his pattern as he goes along—a species of improvising which is quite full of interest to an on-looker. In time the men become very skillful in this sort of work, and are quite ready in thinking out new designs. It is entirely a matter of experience, the work depending largely on a nice sense of touch, since the glass is for the most part obscured by the spattered emery and oil. In this way geometric designs of considerable complication, wreaths and flowers, birds, fishes, and dragons, are traced on goblets and other table-ware, as well as on globes and similar articles. It is also the process by which initials and monograms are cut on glass, and its frequent application for this purpose is familiar to every one who is not near-sighted.

The tracery is accomplished sooner than one would fancy. As a rule, it is used in connection with some other form of ornamentation. Frequently in the case of globes there is a light tracery around the central portion, and plain bands at the top and bottom. These are put on very expeditiously, and, consequently, at little cost. The process is known technically as "obscuring." The globes are mounted on a lathe over a sand-box, being fastened between plates of cork in order that they shall not be fractured by the jar. The workman presses a bundle of soft, annealed iron wire against the surface of the quickly rotating globe, and, almost in less time than it takes one to tell about it, the band is completed. The band at the other end of the globe is put on in the same way. If two parallel bands are to be put on near together, the bundle of wire is in two parts, and both bands are made at the same time. The wires simply determine where the obscuring shall be. The real grinding is done by the sand and water with which the surface of the globe is kept constantly supplied. By using a larger bundle of wire, and passing it over the entire surface of the globe, the obscuring is made complete, and we have the so-called ground-glass globe.

The obscuring process is used in connection with both cutting and engraving, a design frequently being brought out much more beautifully by reason of the obscured or translucent background. In this case, however, the cut pattern must not be subjected to the final brushing process, for the glass brush would smooth the obscured surface and give it the almost transparent character displayed by ground glass when moistened with oil or water. The effect would be to make the portion of the glass around the cutting look constantly wet—an undesirable form of decoration. Some of the most pleasing designs are thus produced by a combination of two or more processes. However fully and artistically a plain glass globe may be decorated, there is apt to be an unpleasant effect of thinness of design from the unrestricted pas-

sage of the light through the transparent portions. But by obscuring the entire surface of the globe, and then cutting even a very modest design upon the background so prepared, the result is much more effective. The transmitted light, from its subdued character, is also more agreeable. The cutting is done in the so-called "mud-box"—a designation which has arisen from the fact that the spent sand or mud from the cutting of heavier articles is here utilized.

FIG. 6.—PRINTING THE DESIGNS AND WRAPPING THE GLOBES, PRIOR TO THE ETCHING.

These processes are all purely mechanical. They depend upon the direct friction between the glass and the abrading powder, or between the glass and the cutting stone, as in the case of the smoothing process. It is possible, however, to bring about this grinding action by less direct pressure. One of these indirect methods—the sand-blast—deserves particular mention, both because of its commercial importance and because of its ingenuity. Some years ago there was published a book which pointed out, with more or less cunning, a prototype in nature for nearly all our mechanical devices. The author did not, I believe, mention the sand-blast, but he might well have done so, for it is a direct imitation, though perhaps an unconscious one, of a process which Nature has been using very effectively ever since the first blast of wind carried the earliest sand-grains against the Eozoic rocks. This natural sand-blast has done not a little in altering the appearance of the face of the earth. In the Rocky Mountains there are many curiously sculptured rocks in the comparatively rainless districts, which owe their carving almost entirely to this

agency. Still more striking, perhaps, has been the effect of blowing sand upon the monuments of antiquity. Those who have seen the Obelisk, in Central Park, New York, or have read descriptions of it, will probably recall the fact that on those sides which were originally exposed to the desert wind the hieroglyphics have been entirely worn off by the grinding action of centuries of blowing sand. The action is precisely the same in the atelier, except as to the matter of time. A strong blast of air, charged with particles of sharp, clean sand, will obscure a plain glass surface in the course of a few seconds. It is applied very ingeniously. The design to be traced on the glass is cut out of soft rubber, and the stencil thus formed is held firmly against the surface. The blast of sand-carrying air is secured by means of an exhaust, and is so arranged that it may be made to enter a sheet-iron box placed so that its upper surface shall be at about the level of an ordinary table. There is a round opening in the top of the box, somewhat larger than the pattern to be ground, but not so large as the sheet of rubber in which it is cut. Glass and rubber are then pressed against the opening, and, by means of a pedal, the blast is turned on. In a very short time, scarcely more than five or ten seconds, the blast is turned off, and the stenciled pattern is found ground on the glass. So quickly does the blast do its work that the capacity of the machine may be said to be limited only by the speed with which the operator can adjust things.

FIG. 7.—THE PROCESS OF ETCHING.

The action of the blast is rather interesting. The soft-rubber stencils will endure many exposures, while the hard flint glass is perceptibly worn away in a few seconds. The reason of this is

that the little particle of moving sand can not be brought to rest immediately. However quickly its flight is arrested, there is an appreciable interval of time during which its motion must be parted with. Striking against the soft and flexible rubber, the sand is brought to rest gradually, for the rubber is sufficiently depressed by the Lilliputian blow to dispose of the motion stored up in the particle. When, however, the sand strikes against the hard and rigid glass, there is no giving way possible. The grains must either stop instantly or else they must penetrate between the molecules of the glass. In the latter case they would naturally detach little fragments in sufficient number to roughen the surface of the glass and make it translucent. Experience shows that this is precisely what happens. If the naked hand be held over the blast, a pricking sensation is felt, but the skin is not broken; it is too pliable. Thin sheet-iron stencils are sometimes substituted for those of rubber; their elasticity makes them fairly durable.

The sand-blast was invented by an American, but, as the original patent has expired, any one is at liberty to use the machine. The inventor has since made a number of modifications and improvements, which are protected by subsequent patents. The newer form is used, I believe, more in England than in this country—not so much from a failure on our part to appreciate its merits, as from a dislike of the peculiar royalty arrangements. The machines are sold, and a certain royalty charged each week, whether the works are running or not. As such an arrangement makes the expense a constant quantity, while the income is a variable, it is not acceptable to the majority of American glass-workers.

Other agents besides mechanical find employment in the atelier. One of the properties of glass which makes it most highly esteemed, in both the household and the laboratory, is its almost total indifference at ordinary temperatures to acids and other corrosive chemicals. It is slightly acted upon by the strongest sulphuric acid and by steam under great pressure, but only after the lapse of considerable time. There are few substances, however, which are not, Achilles-like, vulnerable in some one particular. In the case of glass, the effective solvent is the comparatively rare compound, hydrofluoric acid. It is not strange, therefore, that in the numerous manipulations to which glass is subjected this fact should be utilized. It forms the basis of the one chemical process of the atelier, that of etching. It is a process readily and cheaply carried out, and from its effectiveness it is one of increasing importance. The piece of glassware to be treated is protected, in those parts which it is desired shall not be acted upon by the acid, by some substance indifferent to it, such as wax, paraffin, or a

specially prepared ink. The parts not coated are thus the only ones exposed when the piece is plunged into the bath of hydrofluoric acid. They are soon bitten by the acid, and in this way the design is traced upon the glass. As globes for lamps and gas are the subjects most frequently chosen for this treatment, the process can, perhaps, best be understood by following such an article through the several stages of its decorative development. The designs are adapted from a variety of sources. The draughtsman is supplied with drawing-books containing examples of conventionalized flowers. From this unit he works out a design of proper size and shape—that is, something which when wrapped around the globe shall cover just one half of it, and so, by repetition, the whole. He traces his designs on a panel of heavy plate

FIG. 8.—FOUR STAGES: To the right, the plain ground globe; then the globe wrapped in printed paper; next, the printed globe, with the paper removed; and finally, to the left, the finished product.

glass. The surface is coated with a special ink made of lampblack, rosin, and wax, and the design then picked out by means of a sharp tool. The plate, thus prepared, is subjected to the action of a strongly acid bath of hydrofluoric acid for a period of from fifteen to twenty minutes. The uncovered parts of the plate are deeply eaten away. The ink is then washed off, and the plate is ready to print from. Frequently designs are etched on both sides of the panel, both for economy of material and of storage.

The printing is done on a simple engraver's press, the impressions being taken upon smooth, white paper, somewhat heavier than tissue. As the ink used for the purpose has a decided tend-

ency to become stiff and unmanageable in the cold, a gas-flame is kept constantly burning under the engraving plate. The sheets of paper as they come from the press are covered with a thick layer of ink in those portions which correspond to the parts of the globe not to be etched. While still fresh, the printed sheets are passed to a girl sitting at a neighboring table. She cuts off the superfluous paper surrounding the design, and wraps the print around the globe to be treated. A second print serves to cover the globe completely. The paper is pressed tightly against the glass, and the wrapped-up globe then warmed over a gas-stove for a few moments. The paper is left on for a day or so, and when it is finally removed the design is found transferred to the glass. It will be seen that the process is not unlike that by which in former years decalcomania were attached to china and marble, to their supposed ornamentation.

The globe is now a study in black and white, and is ready for the etching proper.

The acid-room—for such is the name applied to the apartment where the etching process is carried out—is a truly villainous place. The atmosphere is so charged with hydrofluoric acid that it has a sharp smell and a most irritating effect upon the bodily economy generally. The instantaneous photograph of the bath had to be taken with more than customary expedition, lest the ninety-dollar lens in use should be fouled by the fumes. The man in charge of the process wears rubber gloves, and has his face partially protected from the fumes by a thick, bluish-white ointment. His appearance, in consequence, is far from prepossessing. The protection, however, is of a very superficial character. It leaves the eyes and the breathing apparatus entirely exposed. The operators soon show the ravages of the unwholesome atmosphere. Poor, pale ghosts of men, with red and blinking eyes, one wonders that, in a world so full of wholesome activities, they should be willing to sacrifice the best part of themselves in such an unnecessary cause. It is one of the saddest features of modern industrial life that things become so vastly more important than men, that both employers and employed—the responsibility is a joint one—come to look upon the ledger account as the first consideration and manhood the second. Dainty as are the products of this industrialism, I find myself taking less pleasure in them as I go more among the workers, and see what a price of dull routine and unwholesome labor is paid for the wares. If beautiful things are necessarily the product of unbeautiful lives, I am quite willing to forego the things. Under the present industrial *régime*, one feels almost an accessory to the degradation of human life if he purchase articles made on a large scale under the factory system. Morally, there is complicity, however unwilling we may be to admit it. It

is a question worth considering whether political freedom and industrial slavery represent an ideal with which any people may worthily remain content. An industrialism is conceivable, with hours so reasonable and conditions so wholesome that the lives of the workers shall be as beautiful as the wares they produce. Whether this will result from the present competitive system carried to its extreme, or from a substituted co-operative system, remains to be seen. In the atelier, the main process in operation is the transformation of moving, human energy into the stored-up

FIG. 9.—THE PORTLAND VASE.

energy represented by a highly wrought product. One may be pardoned, then, if his thought turns occasionally upon the source of the energy, the man. It is not an agreeable reflection to present to the reader that the majority of our brothers in large cities are living bitter, hateful lives, but I believe that it is a true one. It is perhaps well to entertain the thought for a moment, since our people, presumably sympathetic and compassionate, not only

do not deplore this sacrifice of the best elements in human life, but on the contrary hold up as an ideal for whose protection and extension the national policy should chiefly exert itself, that very industrialism under which this sacrifice takes place. Food, clothing, shelter, and the household goods and gods have value only as they minister to human life. But, by a curious inversion, these things are now held to be of greater importance than the life which they were originally intended to conserve. The savagery of modern times wears a different garb from that of the past, but it is none the less of the essence.

But to return to the acid-worker, for his besmeared face and irritated eyes are still before us. The three windows of the little room in which he works are kept open winter and summer, in the hope of diluting the poisonous fumes—a clumsy arrangement at the best. It would be quite possible to have the atmosphere, if not entirely wholesome, at least comparatively so, by placing the acid bath directly under a good flue or exhaust, so that the escaping fumes should be drawn off artificially. Every chemist's laboratory contains such an evaporating closet.

The hydrofluoric acid employed for etching is a chemical unfamiliar to the majority of people. Its corrosive character, and the fact that it has few common uses, preclude such an acquaintance. The source of the acid, however, the mineral fluor-spar, is quite abundant in nature. It is so beautiful a mineral, occurring in nearly all the colors of the rainbow and in well-defined cubes and octahedra, that it is given a prominent place in all mineralogical cabinets. It is, therefore, probably better known than the acid derived from it. The mineral itself is a fluoride of lime, and, when treated with oil of vitriol, gives off fumes of hydrofluoric acid. These are exceedingly soluble in water, forming the ordinary hydrofluoric acid of commerce. The bath used in etching the globes contains in addition a certain amount of oil of vitriol. Glass plunged into such a bath will have its surface eaten away, but will remain transparent. The wooden trough containing the bath is from three to four feet long, and less than a square foot in cross-section. Half a dozen globes are treated at a time. They are mounted on a steel axle, separated from each other by washers cut out of thick rubber. These serve the double purpose of protecting the glass from injury and of keeping the liquid out of the interior. When the axle is put in place in the trough, the globes are about half submerged in the bath. The axle is given a slow rotary motion, and, at the end of about fifteen minutes, the etching is completed. The globes are removed from the bath, and another axle carrying six fresh globes put in its place. The chemical action consists in the formation of gaseous fluoride of silicon, the bath affording the fluorine and the glass the silicon. It is

rendered more complete and more uniform by the rotary movement of the axle. The globes have now only to be washed, and nothing further remains but to sell them. The etching process is completed.

The solution of hydrofluoric acid leaves the etched portions of the glass transparent; but if some alkaline salt, such as ammonium or potassium sulphate, be present in the bath, the etched portions are rendered opaque. This reaction is utilized to obscure globes, in place of the grinding process already described. The globes have only to be dipped into such a bath for a moment or so, to be thoroughly obscured. As both sides of the glass are acted upon, the process of chemical obscuring is only used where the globe is not to be further decorated. In this same department the operation of "bisquing" is being carried on. If opalescent glass or colored translucent glass be dipped into such an alkaline bath for a brief time, it will take the dull finish characteristic of bisque. Thousands of the so-called fairy lamps, in red and pink and blue opalescent glass, are treated in this manner. Glass surfaces which are subsequently to be painted on are also bisqued in order to facilitate the process. A very brief immersion makes the surface sufficiently rough to write on with an ordinary lead-pencil without the least difficulty. The large white plaques exposed for sale in the art-stores are prepared in this manner. The bath is contained in large wooden tanks, and the articles are simply dipped in by hand.

The products of all these processes—of cutting, engraving, grinding, and etching—are all more or less beautiful. The highest excellence is attained, however, when the several processes are combined in the production of the once greatly admired cameo glass. The best of this is now manufactured in England, but it has also been made, though with less success, in America.

The prototype of this variety of glass is the celebrated Portland vase, with whose history and mishaps most people are familiar. It was found about the sixteenth century in a sarcophagus in the neighborhood of Rome, and for more than two centuries adorned the *salon* of the Barberini family. When their collection was sold, the vase was purchased by the Duchess of Portland, for eighteen hundred and seventy-two pounds, and was loaned to the British Museum. Even in such safe keeping it came very near complete destruction at the hands of a madman named Lloyd, who gave it a heavy blow with a stick. It has since been repaired with such ingenuity that one can scarcely distinguish the numerous fractures. The vase is supposed to date from the time of the Antonines, and is one of the finest examples of ancient glass-making extant. The body is of a deep-blue color and the raised figures are of opaque white. For many years archæologists be-

lieved that the vase was made of onyx, and described it as a most interesting cameo. It is now known to be made of glass composed of two layers.

The Portland vase was a hint to the glass-makers, and one that they made good use of. In the most elaborate examples of the modern product three colors are employed, and the effect, if the material has been judiciously managed, is exceedingly beautiful.

A vase is the best type of the cameo glass, since the function of the ware is almost wholly decorative. From beginning to end the process is one of great ingenuity. The basis of the vase is commonly of opalescent glass—that is, glass made opaque by the presence of some finely ground but insoluble oxide, or some such mineral as cryolite or fluor-spar. A lump of this glass is gathered on the end of the blowpipe and formed into a symmetrical shape by rolling on the marvering-table. It is then dipped at short intervals into two baths of molten glass of the colors desired. The composite lump is fashioned into shape by means of those various manipulations which the glass-blowers perform so adroitly. This gives a vase made up of three distinct layers of different colors. Its subsequent treatment is both chemical and mechanical. The design is painted on the glass by hand, or else transferred with special care from freshly printed paper, as in the case of the etched globes. The vase is then dipped into the bath of hydrofluoric acid and allowed to remain until both of the outer colors on the exposed portions are eaten off. It is now taken out, the ink washed off, and its subsequent treatment intrusted to the engraver. At this stage of the process only two out of the three colors are plainly visible, the intermediate one being seen simply as a colored line between the other two surfaces. By means of the engraving-wheel the outline of the design is made more clear cut, and enough of the outer layer removed to show the intermediate color as a delicate shading. An immense amount of work can thus be put upon a comparatively small article, and the cost meanwhile grows in proportion. Single pieces have been manufactured in England valued as high as two thousand dollars.

In spite of its great beauty and ingenuity, however, it is an undeniable fact that the cameo glass is losing rather than gaining in favor with the buying public. Some of the establishments which formerly produced it have ceased to do so. Several causes have been assigned for this lessened appreciation. Manufacturers say that the cost has been so far reduced that the rich will not buy it, and, in consequence, the middle classes no longer care for it. But such is not the general course of events in industrial matters, and the statement is to be taken with a grain of salt. The probable trouble is, that some of the cameo-ware has been

produced in distressing colors and in unfortunate combinations. Injudiciously managed, it is easily possible to produce meager and inartistic effects. The average buyer has, therefore, been disposed to reckon with himself that, dollar for dollar, he could get more beauty elsewhere, and has accordingly gone there. The intrinsic merit of the ware is such, however, that an early revival of interest in it may be expected.

The processes of the atelier are much more varied than those described. These special ones have been selected as being among the most characteristic, particularly of American establishments. Moreover, they are types, and have an independent interest as ingenious adaptations of means to ends.

Before closing the door upon the atelier, the factor of its *personnel* deserves a moment's attention. I refer now to the workers—not in their social or human capacity, but merely as merchandise-producers. Their labor is expended almost exclusively in the creation of supposed beauty. It is true that the work is lavished for the most part upon objects of utility; but still it would all fall under the head of ornamentation, since the utilitarian quality in the products has been conferred elsewhere than in the atelier. It is curious, then, in view of this end, to find the workers of the most inartistic cult. In other departments of glass-making, and notably in the production of picture-windows, the possibilities of the material have attracted artists of the highest rank, and the results have been quite worthy of their effort. No such artistic invasion has taken place in this department. Considering the lives and training of the workers, the surprise is that they have realized as much beauty as they have. There is nothing in the atmosphere they breathe to cultivate such a sentiment. It is related of a celebrated Japanese *cloissonné*-maker that, having acquired a considerable sum of money from the sale of some of his choice wares at one of the Paris expositions, he expended the entire amount in the creation of a beautiful garden around his work-rooms, believing that such an environment would inspire his people to produce even more beautiful wares. I presume that a spirit such as this is possible only where one works for excellence rather than for money.

According to Dr. S. T. Hickson, a naturalist-traveler, the people of the island of Sangir, near Celebes, suppose that, when a man is sick, his proper soul is driven out of him and replaced by a *sakit*, or soul of sickness; and they employ, to eject the evil spirit, a means of mild persuasion. God-cages or god-canoes, made of wood and ornamented with twigs and leaves, are hung up in the patient's dwelling, in which the *sakit*, if pleased with the substance and design of the structure, will take up its abode; after which, it is supposed, the sick man will immediately recover.

ATMOSPHERIC DUST.*

By Dr. WILLIAM MARCET, F.R.S.

THE infinitely small particles of matter we call *dust*, though possessed of a form and structure which escape the naked eye, play important parts in the phenomena of nature. A certain kind of dust has the power of decomposing organic bodies and bringing about in them definite changes known as putrefaction, while other kinds exert a baneful influence on health, and act as a source of infectious diseases. Again, from its lightness and extreme mobility, dust is a means of scattering solid matter over the earth. It may float in the atmosphere as mud does in water, and, blown by the wind, will perhaps travel thousands of miles before again alighting on the earth. Thus Ehrenberg, in 1828, detected in the air of Berlin the presence of organisms belonging to African regions; and he found in the air of Portugal fragments of infusoria from the prairies of America. The smoke of the burning of Chicago was, according to Mr. Clarence King, seen on the Pacific coast.

Dust is concerned in many interesting meteorological phenomena, such as fogs, as it is generally admitted that fogs are due to the deposit of moisture on atmospheric motes. Again, the scattering of light depends on the presence of dust, as is shown in one of Tyndall's interesting experiments. There is no atmosphere without dust, although it varies much in quantity, from the summit of the highest mountain, where the least is found, to the low plains, at the sea-side level, where it occurs most abundantly.

The origin of dust may be looked upon, without exaggeration, as universal. Trees shed their bark and leaves, which are powdered in dry weather and carried about by ever-varying currents of air; plants dry up and crumble into dust; the skin of man and animal is constantly shedding a fine material of a scaly form. The ground in dry weather, high roads under a midsummer's sun, emit clouds of dust consisting of very fine particles of earth. The fine river and desert sand, a species of dust, is silica ground down into a fine powder under the action of water. If the vegetable and mineral world crumbles into dust, on the other hand it is highly probable that dust was the original state of matter before the earth and heavenly bodies were formed; and here we enter the region of theory and probabilities. While it is best to avoid as much as possible stepping out of the track of known

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facts, there is a limit to physical observation, and in some cases we can do no more than glance into the possible or probable source of natural phenomena.

This has been done, as to the origin of the universe, by Prof. Norman Lockyer, in his article on the History of a Star. The author proposes there to clear in our imagination a limited part of space, and then set possible causes to work: that dark void will sooner or later be filled with some form of matter so fine that it is impossible to give it a chemical name; but the matter will eventually condense into a kind of dust mixed with hydrogen gas, and constitute what are called nebulæ. These nebulæ are found by spectrum analysis to be made up of known substances, which are magnesium, carbon, oxygen, iron, silicon, and sulphur. This dust comes down to us in a tangible form—dust shed from the sky on the earth, and large masses, magnificent specimens of meteorites, which have fallen from the heavens at different times, some of them weighing tons. There are swarms of dust traveling through space, and their motion may be gigantic. From photographs taken of the stars and nebulæ, we are entitled to conclude that the swarms of dust meet and interlace each other, becoming raised by friction and collision to a very high temperature, and giving rise to what looks like a star. The light would last so long as the swarms collide, but would go out should the collision fail; or, again, such a source of supply of heat may be withdrawn by the complete passage of one stream of dust-swarms through another. We shall, therefore, have various bodies in the heavens, suddenly or gradually increasing or decreasing in brightness, quite irregularly, unlike those other bodies where we get a periodical variation in consequence of the revolution of one of them round the other. Hence, as Mr. Lockyer expresses it, "it can not be too strongly insisted upon that the chief among the new ideas introduced by the recent work is that a great many stars are not stars like the sun, but simply collections of meteorites, the particles of which may be probably thirty, forty, or fifty miles apart." These swarms of dust undergo condensation by attraction or gravitation; they will become hotter and brighter as their volume decreases, and we shall pass from the nebulæ to what we call true stars. Mr. Lockyer imagines such condensed masses of meteoric dust being pelted or bombarded by meteoric material, producing heat and light, the effect continuing as long as the pelting is kept up. To this circumstance is due the formation of stars like suns. Our earth originally belonged to that class of heavenly bodies, but from a subsequent process of cooling assumed its present character.

The dust scattered everywhere in the atmosphere, which is lighted up in a sunbeam or a ray from the electric lamp, is of

an organic nature. It is seen to consist of countless motes, rising, falling, or gyrating, although it is impossible to follow any of them with the eye for longer than a fraction of a second. We conclude that their weight exceeds but very slightly that of the air; and, moreover, that the atmosphere is the seat of multitudes of minute currents, assuming all kinds of directions. One day last June, from the top of Eiffel's Tower in Paris, I amused myself by throwing an unfolded newspaper over the railing round the summit of the tower. At first it fell slowly, carried away by a light breeze; but presently it rose, and, describing a curve, began again to fall. As it was vanishing from sight, the paper seemed to me as if arrested now and then in its descent, perhaps undergoing again a slight upheaval. Here was, indeed, a gigantic mote floating in the atmosphere, and subject to the same physical laws, though on a larger scale, as those delicate filaments of dust we see dancing merrily in a sunbeam.

It is difficult to say how much of the dust present in the air may become a source of disease, and how much is innocuous. Many of the motes belong to the class of micro-organisms; and experiments show how easily these micro-organisms or sources of infectious diseases can reach the lungs, and do mischief if they should find a condition of the body on which they are able to thrive and be reproduced. Atmospheric motes, although it has been shown that they are really deposited in the respiratory organs, do not accumulate in the lungs and air-passages, but undergo decomposition and disappear in the circulation. Smoke, which is finely divided coal-dust, is clearly subjected to such a destructive process; otherwise the smoky atmosphere of many of our towns would soon prove fatal, and tobacco-smoke would leave a deposit interfering seriously after a very short time with the process of respiration. Dust, however in its physical aspect is very far from being always innocuous, and many trades are liable to suffer from it. The cutting of chaff, for horses' food, is one of the most pernicious occupations, as it generates clouds of dust of an essentially penetrating character. Persons engaged in needle manufacturing and steel-grinders suffer much from the dust of metallic particles. Stone-cutters, and workmen in plaster of Paris, coal-heavers, men engaged in the manufacture of cigars and rope, those employed in flour-mills and hat and carpet making, are liable to suffer from dust. A number of methods have been adopted, more or less successfully, to rid these trades of the danger due to this source. I observed many years ago that charcoal has the power of retaining dust in a remarkable degree, and having had respirators made of it, found them very effective in preventing dust reaching the lungs.

Micro-organisms—dust-like particles capable of cultivation or

reproduction in certain media and at certain temperatures—are scattered everywhere in the atmosphere. Interesting inquiries into their distribution in air and water have been made by Dr. Miquel at the Montsouris Observatory, Paris, and by Dr. Percy Frankland in England. Dr. Frankland has found that the number present is much reduced in winter. Experiments made in inclosed places, where there is little or no aërial motion, show the number of suspended organisms to be very moderate; but as soon as any disturbance in the air occurs, from draughts or people moving about, the number rapidly increases and may become very great. Being slightly heavier than air, they have an invariable tendency to fall, and on that account collect on the surface of water. Hence rivers, lakes, and ponds are constantly being thus contaminated.

Important points connected with dust of organic origin are its inflammability and its liability to explode when mixed with air. The property of explosiveness was forcibly illustrated in the destruction of six flour-mills by this cause in Minneapolis, Minn., in May, 1878. Coal-dust in coal-mines is a cause of accident from explosions which has been closely investigated in England, Germany, and other mining countries. The subject was thoroughly treated by Sir Frederick Abeel, in a paper on Accidents in Mines, read before the Institution of Civil Engineers in 1888.

Extremely fine particles of mineral dust may exist in the atmosphere, and do exist there more frequently than is generally thought, while they escape detection by our senses. The author, while making experiments on the Peak of Teneriffe, in 1878, found the knife-edges of his balance so clogged with this invisible dust that the balance refused to act. When wiped off, the dust collected again in a few minutes, and it was only by continually wiping it away that he was able to go on with his investigation. Prof. Piazzi Smyth, while on the Peak of Teneriffe, witnessed strata of dust rising to a height of nearly a mile, reaching out to the horizon in every direction, and so dense as to hide frequently the neighboring hills. Prof. S. P. Langley, looking down from the height of fifteen thousand feet on Mount Whitney, California, into a region that had appeared clear from the valley below, saw "a kind of level dust ocean, invisible from below, but whose depth was six or seven thousand feet, as the upper portion only of the opposite mountain-range rose clearly out of it."

Dust storms are classified by Dr. Henry Cook, according to their intensity, as atmospheric dust, dust columns, and dust storms. Dr. Cook has observed in India that there are some days on which, however hard and violently the wind may blow, no dust accompanies it, while on others every little puff of air or current of wind forms or carries with it clouds of dust. If the wind which

raises the dust is strong, nothing will be visible at the distance of a few yards, and the sun will be obscured. The dust penetrates everywhere, and can not be excluded from houses, boxes, and even watches, however carefully guarded. The individual particles of sand appear to be in such an electrical condition that they are ever ready to repel each other, and are consequently disturbed and carried up into the air. Dust columns are regarded by Dr. Cook as due to electrical causes. On calm, quiet days, when hardly a breath of air is stirring, and the sun pours down its heated rays with full force, little eddies arise in the atmosphere near the surface of the ground. These increase in force and diameter, catching up and whirling round bits of sticks, grass, dust, and lastly sand, until a column is formed of great height and considerable diameter, which usually, after remaining stationary for some time, sweeps away across country at great speed. Ultimately it loses gradually the velocity of its circular movement and disappears. In the valley of Mingochar, which is only a few miles in width, and surrounded by high hills, Dr. Cook, on a day when not a breath of air was stirring, counted upward of twenty of these columns. They seldom changed their places, and, when they did so, moved but slowly across the level tract. They never interfered with one another, and appeared to have independent existences. Mr. P. L. H. Baddeley, in his book on Whirlwinds and Dust Storms of India, tells of a gentleman at Lahore who fixed an electrometer apparatus, so adjusted as to report atmospheric electrical movements, and observed that it was strongly affected during dust storms.

Volcanic dust consists mainly of powdered vitrified substances, reduced by the action of intense heat. It is interesting in many respects. The ashes or scoria shot out in volcanic eruptions are mostly pounded pumice, but they also originate from stones and fragments which are pulverized by striking against each other. Volcanic dust has a whitish-gray color, and is sometimes nearly white. Thus it is that, in summer, the terminal cone of the Peak of Teneriffe appears from a distance as if covered with snow; but there is no snow on the mountain at that season of the year, and the white cap of the peak is due to pumice ejected centuries ago.

The friction caused by volcanic stones and rocks as they are crushed in their collision develops a mass of electricity which shows itself in brilliant displays of branch lightning darting from the edges of the dense ascending column. During the great eruption of Vesuvius in 1822 they were constantly visible, and added much to the grandeur of the spectacle. It not unfrequently happens that the dust emitted from Vesuvius falls into the streets of Naples; but this is nothing in comparison with the mass of finely powdered material which covered and buried the towns of Pompeii,

Herculaneum, and Stabiæ, in the year 79. The eruption of Krakatoa, in 1883, exceeded, in all probability, in its deadly effects, and as a wonderful phenomenon of nature, the outburst of Vesuvius in the year 79. It is shown, in the report of the Krakatoa Committee of the Royal Society, that the detonations caused by the explosive action were heard a hundred and fifty miles away. Captain Thompson, of the ship Medea, sailing at a point seventy-six miles northeast of Krakatoa, saw a black mass like smoke rising into the clouds to an altitude which was estimated as not less than seventeen miles. All the eye-witnesses agree as to the splendor of the electrical phenomena. The old crater of Krakatoa was eviscerated, and a cavity was formed more than a thousand feet deep. On the morning of the 27th of August three vessels at the eastern entrance of the Strait of Sunda encountered the fall of mingled dust and water, which soon darkened the air, and covered their decks and sails with a thick coating of mud. Some of the pieces of pumice falling on the Sir R. Sale were said to have been of the size of a pumpkin. All that day the three vessels were beating about in darkness, pumice-dust falling upon them in such quantities as to employ the crews for hours in shoveling it from the decks and in beating it from the sails and rigging. The speed and distance attained by the pumice ejected from the volcano may be conceived from the fact stated in Mr. Douglas Archibald's contribution to the report, that dust fell on September 8th more than thirty-seven hundred English miles from the seat of the eruption. The great mass of the pumice was of a dirty, grayish-white tint, and was very irregular in size.

The dust ejected from Krakatoa did not all fall back at the same time upon the sea and the earth. The lightest portion formed into a haze, which was as a rule propagated westward. Most observers agree in regarding this haze as the proximate cause of the twilight glows, colored suns, and large corona which were seen for a long time (more than two years) after the eruption. The haze was densest in the Indian Ocean and along the equatorial belt, and was often thick enough to hide the sun when within a few degrees of the horizon.

I hope I have succeeded in showing that infinitely small objects, no larger than particles of dust, act important parts in the physical phenomena of nature.

Mr. H. W. Seton-Karr tells, in one of his books of travels, of his ascent of one of the spurs of Mount St. Elias, following the track of a brown bear with always an uneasy expectation of meeting the animal itself, to the height of seven thousand two hundred feet. Here the wonderful spectacle was presented of no less than seventeen thousand square miles of glaciers stretching over the face of the country. Excepting Greenland, according to this traveler, these glaciers are the most extensive in the world outside of the arctic and antarctic regions.

ON JUSTICE.

By HERBERT SPENCER.

[*Concluded.*]

IV. The Sentiment of Justice.—Acceptance of the doctrine of organic evolution determines certain ethical conceptions. The doctrine implies that the numerous organs in each of the innumerable species of animals, have been either directly or indirectly molded into fitness for the requirements of life by constant converse with those requirements. Simultaneously, through nervous modifications, there have been developments of the sensations, instincts, emotions, and intellectual aptitudes, needed for the appropriate uses of these organs; as we see in caged rodents that exercise their incisors by purposeless gnawing, in gregarious creatures which are miserable if they can not join their fellows, in beavers which, kept in confinement, show their passion for dam-building by heaping up whatever sticks and stones they can find.

Has this process of mental adaptation ended with primitive man? Are human beings incapable of having their feelings and ideas progressively adjusted to the modes of life imposed on them by the social state into which they have grown? Shall we suppose that the nature which fitted them to the exigencies of savage life has remained unchanged, and will remain unchanged, by the exigencies of civilized life? Or shall we suppose that this aboriginal nature, by repression of some traits and fostering of others, is made to approach more and more to a nature which finds developed society its appropriate environment, and the required activities its normal ones? There are many believers in the doctrine of evolution who seem to have no faith in the continued adaptability of mankind. While glancing but carelessly at the evidence furnished by comparisons of different human races with one another, and of the same races in different ages, they ignore entirely the induction from the phenomena of life at large. But if there is an abuse of the deductive method of reasoning there is also an abuse of the inductive method. One who refused to believe that a new moon would in a fortnight become full, and, disregarding observations accumulated throughout the past, insisted on watching the successive phases for three weeks before he was convinced, would be considered inductive in an irrational degree. But there might not unfairly be classed with him those who, slighting the inductive proof of unlimited adjustability, bodily and mental, which the animal kingdom at large presents, will not admit the adjustability of human nature to social life until the adjustment has taken place: nay, even ignore the evidence that it is taking place.

Here we shall assume it to be an inevitable inference from the doctrine of organic evolution, that the highest type of living being, no less than all lower types, must go on molding itself to those requirements which circumstances impose. And we shall, by implication, assume that moral changes are among the changes thus wrought out.

The fact that when surfeit of a favorite food has caused sickness, there is apt to follow an aversion to that food, shows how, in the region of the sensations, experiences establish associations which influence conduct. And the fact that the house in which a wife or child died, or in which a long illness was suffered, becomes so associated with painful states of mind as to be shunned, sufficiently illustrates, in the emotional region, the mode in which actions may be determined by mental connections formed in the course of life. When the circumstances of a species make certain relations between conduct and consequence habitual, the appropriately-linked feelings may come to characterize the species. Either inheritances of modifications produced by habit, or more numerous survivals of individuals having nervous structures which have varied in fit ways, gradually form guiding tendencies, prompting appropriate behavior and deterring from inappropriate. The contrast between fearless birds found on islands never before visited by man, and the birds around us, which show fear of man immediately they are out of the nest, exemplifies such adaptations.

By virtue of this process there have been produced to some extent among lower creatures, and there are being further produced in man, the sentiments appropriate to social life. Aggressive actions, while they are habitually injurious to the group in which they occur, are not unfrequently injurious to the individuals committing them; since, though certain pleasures may be gained by them, they often entail pains greater than the pleasures. Conversely, conduct restrained within the required limits, calling out no antagonistic passions, favors harmonious co-operation, profits the group, and, by implication, profits the average of its individuals. Consequently, there results, other things equal, a tendency for groups formed of members having this adaptation of nature, to survive and spread.

Among the social sentiments thus evolved, one of chief importance is the sentiment of justice. Let us now consider more closely its nature.

Stop an animal's nostrils, and it makes frantic efforts to free its head. Tie its limbs together, and its struggles to get them at liberty are violent. Chain it by the neck or leg, and it is some time before it ceases its attempts to escape. Put it in a cage, and

it long continues restless. Generalizing these instances we see that in proportion as the restraints on actions by which life is maintained are extreme, the resistances to them are great. Conversely, the eagerness with which a bird seizes the opportunity for taking flight, and the joy of a dog when liberated, show how strong is the love of unfettered movement.

Displaying like feelings in like ways, man displays them in other and wider ways. He is irritated by invisible restraints as well as by visible ones; and as his evolution becomes higher, he is affected by circumstances and actions which in more remote ways aid or hinder the pursuit of ends. A parallel will elucidate this truth. Primitively the sentiment of property is gratified only by possession of food and shelter, and, presently, of clothing; but afterward it is gratified by possession of the weapons and tools which aid in obtaining these, then by possession of the raw materials serving for making weapons and tools and for other purposes, then by possession of the coin which purchases them as well as things at large, then by possession of promises to pay exchangeable for the coin, then by a lien on a banker, registered in a pass-book. That is, there comes to be pleasure in an ownership more and more abstract and remote from material satisfactions. Similarly with the sentiment of justice. Beginning with the joy felt in ability to use the bodily powers and gain the resulting benefits, accompanied by irritation at direct interferences, this gradually responds to wider relations: being excited now by the incidents of personal bondage, now by those of political bondage, now by those of class privilege, and now by small political changes. Eventually, this sentiment, sometimes so little developed in the negro that he jeers at a liberated companion because he has no master to take care of him, becomes so much developed in the Englishman that the slightest infraction of some mode of formal procedure at a public meeting or in Parliament which can not intrinsically concern him, is vehemently opposed because in some distant and indirect way it may help to give possible powers to unnamed authorities who may perhaps impose unforeseen burdens or restrictions.

Clearly, then, the egoistic sentiment of justice is a subjective attribute which answers to that objective requirement constituting justice—the requirement that each adult shall receive the good and evil effects of his own nature. For unless the faculties of all kinds have free play, these results can not be gained or suffered, and unless there exists a sentiment which prompts maintenance of the sphere for this free play, it will be trenched upon and the free play impeded.

While we may thus understand how the egoistic sentiment of justice is developed, it is much less easy to understand how there

is developed the altruistic sentiment of justice. On the one hand, the implication is that the altruistic sentiment of justice can come into existence only in the course of adaptation to social life. On the other hand the implication is that social life is made possible only by maintenance of those equitable relations which imply the altruistic sentiment of justice. How can these reciprocal requirements be fulfilled?

The answer is that the altruistic sentiment of justice can come into existence only by the aid of a sentiment which temporarily supplies its place and restrains the actions prompted by pure egoism—a pro-altruistic sentiment of justice as we may call it. This has several components which we must successively glance at.

The first deterrent from aggression is one which we see among animals at large—the fear of retaliation. Among creatures of the same species the food obtained by one or place of vantage taken possession of by it, is in some measure insured to it by the dread which most others feel of the vengeance which may follow any attempt to take it away; and among men, especially during primitive stages of social life, it is chiefly such dread which secures for each man free scope for his activities, and exclusive use of whatever they bring him.

A further restraint is the fear of reprobation shown by unconcerned members of the group. Though in the expulsion of a "rogue" elephant from the herd, or the slaying of a sinning member of the flock by rooks or storks, we see that even among animals individuals suffer from an adverse public opinion; yet it is scarcely probable that among animals expectation of general dislike prevents encroachment. But among mankind, "looking before and after" to a greater extent, the thought of social disgrace is usually an additional check on ill-behavior of man to man.

To these feelings, which come into play before there is any social organization, have to be added those which arise after political authority establishes itself. When a successful leader in war acquires permanent headship, and comes to have at heart the maintenance of his power, there arises in him a desire to prevent the trespasses of his people one against another; since the resulting dissensions weaken his tribe. The rights of personal vengeance and, as in feudal times, of private war, are restricted; and, simultaneously, there grow up interdicts on the acts which cause them. Dread of the penalties which follow breaches of these, is an added restraint.

Ancestor-worship in general, developing as the society develops into special propitiation of the dead chief's ghost, and presently the dead king's ghost, gives to the injunctions he uttered during life increased sanctity; and when, with establishment of

the cult, he becomes a god, his injunctions become divine commands with dreaded punishments for breaches of them.

These four kinds of fear co-operate. The dread of retaliation, the dread of social dislike, the dread of legal punishment, and the dread of divine vengeance, united in various proportions, form a body of feeling which checks the primitive tendency to pursue the objects of desire without regard to the interests of fellow-men. Containing none of the altruistic sentiment of justice, properly so called, this pro-altruistic sentiment of justice serves temporarily to cause respect for one another's claims, and so to make social co-operation possible.

Creatures which become gregarious tend to become sympathetic in degrees proportionate to their intelligences. Not, indeed, that the resulting sympathetic tendency is exclusively, or even mainly, of that kind which the words ordinarily imply; for in some there is little beyond sympathy in fear, and in others little beyond sympathy in ferocity. All that is meant is that in gregarious creatures a feeling displayed by one is apt to arouse kindred feelings in others, and is apt to do this in proportion as others are intelligent enough to appreciate the signs of the feeling. In two chapters of the Principles of Psychology—Sociality and Sympathy and Altruistic Sentiments—I have endeavored to show how sympathy in general arises, and how there is eventually produced altruistic sympathy.

The implication is, then, that the associated state having been maintained among men by the aid of the pro-altruistic sentiment of justice, there have been maintained the conditions under which the altruistic sentiment of justice itself can develop. In a permanent group there occur, generation after generation, incidents simultaneously drawing from its members manifestations of like emotions—rejoicings over victories and escapes, over prey jointly captured, over supplies of wild food discovered; as well as laments over defeats, scarcities, inclemencies, etc. And to these greater pleasures and pains felt in common by all, and so expressing themselves that each sees in others the signs of feelings like those which he has and is displaying, must be added the smaller pleasures and pains daily resulting from meals taken together, amusements, games, and from the not infrequent adverse occurrences which affect several persons at once. Thus there is fostered that sympathy which makes the altruistic sentiment of justice possible.

But the altruistic sentiment of justice is slow in assuming a high form, partly because its primary component does not become highly developed until a late phase of progress, partly because it is relatively complex, and partly because it implies a stretch of

imagination not possible for low intelligences. Let us glance at each of these reasons.

Every altruistic feeling presupposes experience of the corresponding egoistic feeling. As, until pain has been felt there can not be sympathy with pain, and as one who has no ear for music can not enter into the pleasure which music gives to others; so, the altruistic sentiment of justice can arise only after the egoistic sentiment of justice has arisen. Hence where this has not been developed in any considerable degree, or has been repressed by a social life of an adverse kind, the altruistic sentiment of justice remains rudimentary.

The complexity of the sentiment becomes manifest on observing that it is not concerned only with concrete pleasures and pains, but is concerned mainly with certain of the circumstances under which these are obtainable or preventable. As the egoistic sentiment of justice is gratified by maintenance of those conditions which render achievement of satisfactions unimpeded, and irritated by the breaking of those conditions, it results that the altruistic sentiment of justice requires for its excitement not only the ideas of such satisfactions, but also the ideas of those conditions which are in the one case maintained and in the other case broken.

Evidently, therefore, to be capable of this sentiment in a developed form, the faculty of mental representation must be relatively great. Where the feelings with which there is to be sympathy are simple pleasures and pains, the higher gregarious animals occasionally display it: pity and generosity are from time to time felt by them as well as by human beings. But to conceive simultaneously not only the feelings produced in another, but the plexus of acts and relations involved in the production of such feelings, presupposes the putting together in thought of more elements than an inferior creature can grasp at the same time. And when we come to those most abstract forms of the sentiment of justice which are concerned with public arrangements, we see that only the higher varieties of men are capable of so conceiving the ways in which good or bad institutions and laws will eventually affect their spheres of action, as to be prompted to support or oppose them; and that only among these, therefore, is there excited under such conditions that sympathetic sentiment of justice which makes them defend the political interests of fellow-citizens.

There is, of course, a close connection between the sentiment of justice and the social type. Predominant militancy, by the coercive form of organization it implies, alike in the fighting body and in the society which supports it, affords no scope for the egoistic sentiment of justice; but, contrariwise, perpetually tramples on it, and at the same time the sympathies which origi-

nate the altruistic sentiment of justice are perpetually seared by militant activities. Contrariwise, in proportion as the *régime* of *status* is replaced by the *régime* of contract, or, in other words, as fast as voluntary co-operation, which characterizes the industrial type of society, becomes more general than involuntary co-operation, which characterizes the militant type of society, individual activities become less restrained, and the sentiment which rejoices in the scope for them is encouraged; while, simultaneously, the occasions for repressing the sympathies become less frequent. Hence during warlike phases of social life the sentiment of justice retrogrades, while it advances during peaceful phases, and can reach its full development only in a permanently peaceful state.*

V. THE IDEA OF JUSTICE.—While describing the sentiment of justice, the way has been prepared for describing the idea of justice. Though the two are intimately connected they may be clearly distinguished.

One who had dropped his pocket-book, and, turning round, finds that another who has picked it up will not surrender it, is indignant. If the goods sent home by a shopkeeper are not those he purchased, he protests against the fraud. Should his seat at a theatre be usurped during a momentary absence he feels himself ill-used. Morning noises from a neighbor's poultry he complains of as grievances. And meanwhile he sympathizes with the anger of a friend who has been led by false statements to join a disastrous enterprise, or whose action at law has been rendered futile by a flaw in the procedure. But though in these cases his sense of justice is offended, he may fail to distinguish the essential trait which in each case causes the offense. He may have the sentiment of justice in full measure while his idea of justice remains vague.

This relation between sentiment and idea is a matter of course. The ways in which men trespass on one another become more numerous in their kinds, and more involved, as society grows more complex; and they must be experienced in their many forms, generation after generation, before analysis can make clear the essential distinction between legitimate acts and illegitimate acts.

A special reason for this should be recognized. Ideas as well as sentiments must on the average be adjusted to the social state. Hence, as war has been frequent or habitual in nearly all societies, such ideas of justice as have existed have been perpetually con-

* Permanent peace does in a few places exist, and where it exists the sentiment of justice is exceptionally strong and sensitive. I am glad to have again the occasion for pointing out that among tribes called uncivilized, there are some, distinguished by the entire absence of warlike activities, who in their characters put to shame the peoples called civilized. In Political Institutions, §§ 437 and 574, I have given eight examples of this connection of facts taken from races of different types.

fused by the conflicting requirements of internal amity and external enmity.

Already it has been made clear that the idea of justice, or at least the idea of human justice, contains two elements. On the one hand there is that positive element implied by recognition of each man's claims to unimpeded activities and the benefits they bring. On the other hand there is that negative element implied by the consciousness of limits which the presence of other men having like claims necessitates. Two opposite traits in these two components especially arrest the attention.

Inequality is the primordial idea suggested. For if the principle is that each shall receive the benefits and evils due to his own nature and consequent conduct, then since men differ in their powers there must be differences in the results of their actions. Unequal amounts of benefit are implied.

Mutual limitations to men's actions suggest a contrary idea. When it is seen that if each pursues his ends regardless of his neighbor's claims, quarrels must be caused and social co-operation hindered, there arises the consciousness that bounds must be set to the doings of each; and the thought of spheres of action bounded by one another, involves the conception of equality.

Unbalanced appreciations of these two factors in human justice lead to divergent moral and social theories, which we must now glance at.

In some of the rudest groups of men the appreciations are no higher than those which we see among inferior gregarious animals. Here the stronger takes what he pleases from the weaker without exciting general reprobation; while, elsewhere, there is practiced and tacitly approved something like communism. But where habitual war has developed political organization, the idea of inequality becomes predominant. If not among the conquered, who are made slaves, yet among the conquerors, who naturally think of that which conduces to their interest as that which *ought* to be, there is fostered this element in the conception of justice which asserts that superiority shall have the benefits of superiority.

Though the Platonic dialogues may not be taken as measures of Greek belief, yet we may reasonably assume that the things they take for granted were currently accepted. Socrates inquires —"Do you admit that it is just for subjects to obey their rulers?" "I do," replies Thrasymachus.* Though otherwise in antagonism,

* The Republic, Book I, translated by Jowett, p. 159 (edit. of 1871). Instead of "Do you admit," the rendering given by Messrs. Llewelyn Davies and Vaughan is "You doubtless also maintain."

the two agree in this conception of what is just. At a later stage of the inquiry, Glaucon, describing a current opinion, says:

"This, as they affirm, is the origin and nature of justice:—there is a mean or compromise between the best of all, which is to do and not to suffer injustice, and the worst of all, which is to suffer without the power of retaliation; and justice being the mean between the two, is tolerated not as good, but as the lesser evil." And immediately afterward it is said that men "are only diverted into the path of justice by the force of law."*

In this significant passage several things are to be noted. There is first a recognition of the fact, above indicated, that at an early stage the practice of justice is initiated by the dread of retaliation, and the conviction, suggested by experience, that it is on the whole the best to avoid aggression and to respect the limit which compromise implies; there is no recognition of intrinsic flagitiousness in aggression, but only of its impolicy. Further, the limit to each man's actions, described as "a mean of compromise," and respect for which is called "the path of justice," is said to be established only "by the force of law." Law is not considered as an expression of justice otherwise cognizable, but as itself the source of justice; and hence results the meaning of the preceding proposition, that it is just to obey the law. Thirdly, there is an implication that were it not for retaliation and legal penalties, the stronger might with propriety take advantage of the weaker. There is a half-expressed belief that superiority ought to have the advantages of superiority; inequality occupies a prominent place, while equality makes no definite appearance.

The conception here indicated that justice consists in legality, is, toward the close of Book IV, developed into the conception that justice consists "in each of the three classes doing the work of its own class": carpenter, shoemaker, or what not, "doing each his own business, and not another's"; and all obeying the class whose business it is to rule.† Thus the idea of justice is made to include the idea of inequality. Though there is some recog-

* Book II, p. 229.

† On another page there is furnished a typical example of Socratic reasoning. It is held to be a just "principle that individuals are neither to take what is another's, nor to be deprived of what is their own." From this it is inferred that justice consists in "having and *doing* what is a man's own"; and then comes the further inference that it is unjust for one man to assume another's occupation, and "force his way" out of one class into another. Here, then, because a man's own property and his own occupation are both called his own, the same conclusion is drawn concerning both. Two fallacies are involved—the one that a man can "own" a trade in the same way that he owns a coat, and the other that because he may not be *deprived* of the coat he must be *restricted* to the trade. The Platonic dialogues are everywhere vitiated by fallacies of this kind, caused by confounding words with things—unity of name with unity of nature.

nition of equality of positions and claims among members of the same class, yet the regulations respecting community of wives, etc., in the guardian-class, have for their avowed purpose to establish, even within that class, unequal privileges for the benefit of the superior.

But now observe that while in the Greek conception of justice there predominates the idea of inequality, while the idea of equality is inconspicous, the inequality refers, not to the natural achievement of greater rewards by greater merits, but to the artificial apportionment of greater rewards to greater merits. It is an inequality mainly established by authority. The gradations in the civil organization are of the same nature as those in the military organization. Regimentation pervades both, and the idea of justice is everywhere conformed to the traits of the social structure.

And this is the idea of justice proper to the militant type at large, as we are again shown throughout Europe in subsequent ages. It will suffice to point out that along with the different law-established positions and privileges of different ranks, there went gradations in the amounts paid in composition for crimes according to the rank of the injured. And how completely the idea of justice was determined by the idea of rightly-existing inequality, is shown by the condemnation of serfs who escaped into the towns and were said to have "unjustly" withdrawn themselves from the control of their lords.

Thus, as might be expected, we find that while the struggle for existence between societies is going on actively, recognition of the primary factor in justice which is common to life at large, human and sub-human, is very imperfectly qualified by recognition of the secondary factor. That which we may distinguish as the brute element in the conception is but little mitigated by the human element.

All movements are rhythmical, and among others social movements, with their accompanying doctrines. After that conception of justice in which the idea of inequality unduly predominates, comes a conception in which the idea of equality unduly predominates.

A recent example of such reactions is furnished by the ethical theory of Bentham. As is shown by the following extract from Mr. Mill's Utilitarianism (p. 91), the idea of inequality here entirely disappears:

> The Greatest-Happiness Principle is a mere form of words without rational signification, unless one person's happiness, supposed equal in degree (with the proper allowance made for kind), is counted for exactly as much as another's. Those conditions being supplied, Bentham's dictum, "everybody to count for one,

nobody for more than one," might be written under the principle of utility as an explanatory commentary.

Now though Bentham ridicules the taking of justice as our guide, saying that while happiness is an end intelligible to all, justice is a relatively unintelligible end, yet he tacitly asserts that his principle—"everybody to count for one, nobody for more than one," is just; since, otherwise, he would be obliged to admit that it is unjust, and we may not suppose he would do so. Hence the implication of his doctrine is that justice means an equal apportionment of the benefits, material and immaterial, which men's activities bring. There is no recognition of inequalities in men's shares of happiness, consequent on inequalities of their faculties or characters.

This is the theory which Communism would reduce to practice. From one who knows him, I learn that Prince Krapotkin blames the English socialists because they do not propose to act out the rule popularly worded as "share and share alike." In a recent periodical, M. de Laveleye summed up the communistic principle as being "that the individual works for the profit of the State, to which he hands over the produce of his labor for equal division among all." In the communistic Utopia described in Mr. Bellamy's Looking Backward, it is held that each "shall make the same effort," and that if by the same efforts, bodily or mental, one produces twice as much as another, he is not to be advantaged by the difference. At the same time the intellectually or physically feeble are to be quite as well off as others: the assertion being that the existing *régime* is one of "robbing the incapable class of their plain right in leaving them unprovided for."

The principle of inequality is thus denied absolutely. It is assumed to be unjust that superiority of nature shall bring superiority of results, or, at any rate, superiority of material results; and as no distinction appears to be made in respect either of physical qualities or intellectual qualities or moral qualities, the implication is not only that strong and weak shall fare alike, but that foolish and wise, worthy and unworthy, mean and noble, shall do the same. For if, according to this conception of justice, defects of nature, physical or intellectual, ought not to count, neither ought moral defects, since they are one and all primarily inherited.

And here, too, we have a deliberate abolition of that cardinal distinction between the ethics of the family and the ethics of the State emphasized at the outset: an abolition which must eventuate in decay and disappearance of the species or variety in which it takes place.

After contemplation of these divergent conceptions of justice, in which the ideas of inequality and equality almost or quite ex-

clude one another, we are prepared for framing a true conception of justice.

In other fields of thought it has fallen to my lot to show that the right view is obtained by co-ordinating the antagonist wrong views. Thus, the association-theory of intellect is harmonized with the transcendental theory on perceiving that when, to the effects of individual experiences are added the inherited effects of experiences received by all ancestors, the two views become one. So, too, when the molding of feelings into harmony with requirements, generation after generation, is recognized as causing an adapted moral nature, there results a reconciliation of the expediency-theory of morals with the intuitional theory. And here we see that the like occurs with this more special component of ethics now before us.

For if each of these opposite conceptions of justice is accepted as true in part, and then supplemented by the other, there results that conception of justice which arises on contemplating the laws of life as carried on in the social state. The equality concerns the mutually-limited spheres of action which must be maintained if associated men are to co-operate harmoniously. The inequality concerns the results which each may achieve by carrying on his actions within the implied limits. No incongruity exists when the ideas of equality and inequality are applied the one to the bounds and the other to the benefits. Contrariwise, the two may be, and must be, simultaneously asserted.

Other injunctions which ethics has to utter do not here concern us. There are the self-imposed requirements and limitations of private conduct, forming that large division of ethics treated of in Part III; and there are the demands and restraints included under Negative and Positive Beneficence, to be hereafter treated of, which are at once self-imposed and in a measure imposed by public opinion. But here we have to do only with those claims and those limits which have to be maintained as conditions to harmonious co-operation, and which alone are to be enforced by the society in its corporate capacity.

Any considerable acceptance of so definite an idea of justice is not to be expected. It is an idea appropriate to an ultimate state, and can be but partially recognized during transitional states; for the prevailing ideas must, on the average, be congruous with existing institutions and activities.

The two essentially-different types of social organization, militant and industrial, based respectively on *status* and on contract, have, as we have above seen, feelings and beliefs severally adjusted to them; and the mixed feelings and beliefs appropriate to intermediate types, have continually to change according to the

ratio between the one and the other. As I have elsewhere shown,* during the thirty—or rather forty—years' peace, and consequent weakening of the militant organization, the idea of justice became clearer: coercive regulations were relaxed and each man left more free to make the best of himself. But, since then, the redevelopment of militancy has caused reversal of these changes; and, along with nominal increases of freedom, actual diminutions of freedom have resulted from multiplied regulations and exactions. The spirit of regimentation proper to the militant type has been spreading throughout the administration of civil life. An army of workers with appointed tasks and apportioned shares of products, which socialism, knowingly or unknowingly, aims at, shows in civil life the same characters as an army of soldiers with prescribed duties and fixed rations shows in military life; and every further act of Parliament which takes from the individual money for public purposes and gives him public benefits, tends more and more to assimilate the two. Germany best shows this kinship. There, where militancy is most pronounced, and where the regulation of citizens is most elaborate, socialism is most highly developed; and from the head of the German military system has now come the proposal of regimental regulations for the working classes throughout Europe.

Sympathy which, a generation ago, was taking the shape of justice, is relapsing into the shape of generosity; and the generosity is exercised by inflicting injustice. Daily legislation betrays little anxiety that each shall have that which belongs to him, but great anxiety that he shall have that which belongs to somebody else For while no energy is expended in so reforming our judicial administration that every one may obtain and enjoy all he has earned, great energy is shown in providing for him and others benefits which they have not earned. Along with that miserable *laissez-faire* which calmly looks on while men ruin themselves in trying to enforce by law their equitable claims, there goes activity in supplying them, at other men's cost, with *gratis* novel-reading!

Evidently, then, amid this chaos of opinions the true idea of justice can be but very partially recognized. The workman who, in pursuance of it, insists on his right of making his own contract with an employer, will continue to be called "a black-leg"; and the writer who opposes the practice of forcibly taking A's property for B's benefit will be classed as an "*a priori* bigot."—*Nineteenth Century.*

* Principles of Sociology, §§ 266, 267; Political Institutions, §§ 573, 574 and 559.

EVIDENCES OF GLACIAL ACTION IN SOUTH-EASTERN CONNECTICUT.

By Hon. DAVID A. WELLS.

REMARKABLE evidences of glacial action in southeastern Connecticut seem thus far to have almost entirely escaped the attention of geologists. In fact, the most superficial survey of the section of country bordering on Long Island and Fisher's Island Sounds, and extending from Connecticut River on the west to Watch Hill, and perhaps to a point farther east, in Rhode Island, can hardly fail to produce a conviction that it was in this region that one, at least, of the great New England glaciers debouched into the waters of the Atlantic; unloading or drop-

Fig. 1.

ping, as its progress was arrested by the ocean, or as it subsequently gradually wasted and receded by change of climate, a vast multitude of bowlders, of which a very large proportion are of uncommon magnitude. There would also seem some reasons for believing that the central or medium line of this glacier is now indicated by the course of the so-called Thames River—which is more properly an arm of the sea rather than a river—

and represents a deep but comparatively narrow cut in the underlying hard granitic rocks; and which, certainly near its mouth, to a depth of fifty feet or more beneath the present river-bottom, as was shown by the recent borings in connection with the construction of the Shore Line Railroad Bridge at New London, is now filled up with mud or coarser detritus. East of the mouth of the Thames River the shores of the mainland, and the surface of the numerous little adjoining islands, are strewed with bowlders—many of large size, and often resting on a highly smoothed basis of bed-rock without the intervention of any surface soil whatever; as is illustrated by Fig. 1, which represents (from a photograph) a bowlder (and the changes in the way of destruction which such masses of rock are undergoing), between Groton and Noank, on the line of the New London and Providence Railroad, and which is a very conspicuous object as seen from the cars, on the left hand side of the track going east.*

The number and size of the bowlders that are strewed over the bottom of Fisher's Island Sound are also a matter of interest and

Fig. 2.

wonderment to even those least acquainted with the subject, who sail over and fish in its shallow waters; while Fisher's Island itself is little other than a mass of bowlders covered in great part by sand, and probably marks the terminal line where a heavy ocean surf arrested the further progress of the glacier by

* All the illustrations accompanying this paper are reproduced from photographic pictures.

breaking in upon its structure, floating off its ice-fragments in the form of bergs or floes, and, by releasing at the same time its heavier rock and gravel constituents, built up a breakwater which, as an island, now forms what is known as "Fisher's Island Sound." Fig. 2 represents a not unfrequent example of the char-

FIG. 3.

acter of the materials which enter into the construction of this natural breakwater, as seen from the western side of this island.

But it is in the region to the east and west of the line of the Thames River, and which it has been suggested may have been the axis of the ancient glacier, and not very far removed from this line, that bowlders of extraordinary size occur most numerously; and among them is a rock which until very recently has been regarded as one of the largest, if not the very largest, bowlder that has thus far been recognized in this or any other country. This rock—of coarse crystalline granite—is situated in the town of Montville, New London County, about six miles south of Norwich, and about a mile west of the Montville Station on the New London and Northern Railroad; and, under the Indian name of "Sheegan," has almost from the first settlement of the country been recognized as a great natural curiosity. Its position is on the edge of a gentle mound or knoll, on the northeast slope of a little valley; and its dimensions, according to recent

measurements by Prof. Crosby, of the Boston Society of Natural History, are as follows: northwest side, forty-six feet; northeast, fifty-eight; southeast, forty-five; southwest, seventy. Maximum height, reckoning from the lower or down-hill side, to the highest point on the upper side, approximately, sixty feet; approximate cubic contents, seventy thousand cubic feet; approximate weight, about six thousand tons. Other and former reported measurements of this rock indicate much larger dimensions than those reported by Prof. Crosby; and, although the determinations of an expert observer like the latter are entitled to the greatest confidence, it is nevertheless true that the form of the rock is so irregular as to render an exact estimate of its size, cubical contents, and weight a matter of no little difficulty. Figs. 3 and 4 give an idea of the position, size, and appearance of the "Sheegan" Rock, as seen from the valley beneath it, looking west. The introduction into the picture of the horse and wagon beneath the rock affords in some degree a standard for estimating its height. The cavity or recess beneath the rock, which is said to have been occupied, at the time of the first settlement of the country, by a

FIG. 4.

Mohegan Indian (from whom the rock undoubtedly derived its name) as a dwelling-place, is sufficiently capacious to admit of being used as a place of shelter for the sleds and other farm implements of the farmer proprietor. A rude ladder on the southern side of the rock affords facilities for reaching its top and obtaining a somewhat extensive view of the surrounding country.

It will probably have been noticed in the above description

that the expression, "has been regarded" as a bowlder, has been employed. The reason of this is, that a recent examination of this rock (in March, 1890) has led Prof. Crosby to the somewhat startling conclusion that it is not a bowlder, but "simply an angular and prominent remnant of a large granite vein, still undisturbed in its original position upon beds of gneiss; and that its chief geological interest is found in the fact that, notwithstanding its

FIG. 5.

exposed position, it has survived the disintegrating influence of the elements and successfully resisted the pressure of the great ice-sheet." Prof. Crosby also states that, "through the undercutting action of the frost, forming quite an extensive rock-shelter" (i. e., the cavity or recess on the lower or valley side), "is afforded an opportunity to observe the actual contact of the massive granite and the finely laminated micaceous gneiss" upon which the granite rests.

For one of very limited experience to dispute the conclusions of such a trained observer as Prof. Crosby would be presumptuous; and yet it would not seem unreasonable to ask that they should not be considered as entirely determinative without a further careful examination of the problem on the part of experts. The question as to whether the contact of the granite of the assumed bowlder and the underlying gneiss is one of situation or of composition is not an easy one for decision, without a very clear opportunity for examination. The fact that such a

huge mass of granite should have resisted the pressure of a great ice-sheet, and remained so prominently in place as part of a vein, when such pressure and an accompanying movement and grinding were sufficient to not only round off and obliterate everything like angularity from the granite surface, but also remove or reduce down to a much lower level and over a large proximate area the whole vast mass of rock on which the granite protuberance, if it be a portion of a vein, must have been as it were originally imbedded, is, as Prof. Crosby admits, a result not a little singular. There is certainly nothing analogous to such a phenomenon in the vicinity, and it may well be questioned whether there is anything similar anywhere.

Furthermore, as throwing some light on this subject, there are, as before stated, in comparative proximity to the "Sheegan" Rock, a large number of undoubted bowlders of the same granite, which, though not comparable as regards size, may yet be regarded as extraordinary, and as clearly involving the exercise of an enormous disrupting and transporting power within a rather limited area. One of these bowlders in the same township of Montville, which is also an object of public curiosity, and known as the "Goal" Rock, is, according to measurements made for the writer, twenty-one feet high, twenty-five long, and twenty-five thick. Another, in the vicinity of Gardner's Lake, from which nearly one fourth of the original mass has been detached in fragments, is reported as eighteen feet six inches high, thirty-five feet long, and twenty feet thick. A third, on the east side of the Thames River, in the town of Preston, is fourteen feet high, twenty feet long, and seventeen feet thick; and at least three or four others in the same region, of similar dimensions, might be enumerated. Above a mile east of "Allen's Point," and on one of the highest of the elevations bordering the river, an area of several acres is so covered with huge bowlders that in places it is difficult to find a path through them; while the southern slope of the same elevation, not far removed, is so strewed with such a multitude of rounded, small bowlders that they have the appearance of having been planted artificially.

Fig. 5 represents an extremely picturesque though not a very large bowlder, on the road between Norwich and Taftville, on the lands of the Ponemah Manufacturing Company, and almost in the center of the village that has within a comparatively few years grown up about it; and which, most fortunately, has thus far been carefully protected by the company against the Vandalic spirit which is so often prompted to mutilate or destroy everything in the nature of a public curiosity.

UTILITY IN ARCHITECTURE.

By BARR FERREE.

IT is a significant commentary on the actual state of our culture that architecture, the most ancient and grandest of the arts, is to-day the least understood, the least satisfactory, the least appreciated of all the achievements of our civilization. This is the more remarkable because there are few periods so prolific of building as our own. There have been times when great and splendid works have been raised by some ambitious ruler who has produced monuments quite unlike anything that is undertaken at the present; but, while we erect no costly palaces or magnificent temples, we build thousands of smaller structures whose combined cost in any one year or term of years greatly exceeds the sums expended on the most elaborate edifices of antiquity in the same time. This is especially the case in our own country, where there is a constant and active demand for buildings of all kinds, for the most expensive as well as the cheapest, for state use and for the individual citizen. And yet, in spite of this undiminished call, which in any department of trade or of manufactures would at once produce the very best results and the most satisfactory methods, the architecture of our time is so thoroughly bad, so wanting in the first principles of common sense, so debased, that this noblest of all the arts is scarcely included in the term, and our critics speak patronizingly of it as just being "gradually recognized" as such.

Architecture has an historical chronology of at least four thousand years during which we can trace its growth, and in which it expressed in a very thorough manner the conditions under which it was developed. It has been reserved for the superior knowledge of modern times to cast it aside as one of the peculiar products of a less intelligent age, as something to admire for its past monuments, but as being quite out of our modern ideas of progress. Because in the last few years a partial revival has taken place; because it has been discovered that it offers a convenient and expensive way of impressing the beholder with the importance of the builder; because our rich men and large corporations want to give some visual evidence of their resources—it has been taken up as something that may be approved of as a means of testifying to the wealth of our cities and adding to their general good looks. The very art element of architecture has been the cause of its degradation. From the most useful of arts, it has become mostly ornamental. From meaning and expressing the utility of an edifice, it has come to refer to its appearance only. People have for-

gotten that it arose from the necessity of man for shelter, and view it as a product of the study or of the studio in which beauty and æsthetic effects are the only ends sought, while utility, convenience, expression of intention, have all become secondary considerations. Nothing could be more erroneous, nothing more fatal to the production of sound architecture.

Architecture is not the product of the imagination, but the result of experience and foresight. The painter in his studio, or the sculptor in his, has nothing to dictate to his thoughts or force them into certain channels. His fancy is free, and he allows it to carry him where it will. The architect, on the other hand, is limited by innumerable requirements and difficulties, all of which are real and physical, and all of which must be overcome before his work can be a success. His creations are not intended for the decoration of a gallery or to be preserved under glass, but they must stand the test of time and of climate, must bear a relation to the manners and customs of the day. He must exercise care and discrimination in the selection of his materials. He must count their cost and be fully acquainted with their physical properties. There is, in fact, no end to the details he must consider, in all of which there is no place or opportunity for the exercise of the imagination. His art is the product of natural conditions, and may be not inappropriately compared to a plant which, through the action of certain external elements or forces, finally assumes a character that can be directly traced to the environment, and which is, in fact, directly dependent on it.

These views are not those popularly held on the subject, but it is impossible to make an intelligent study of the history of the art without reaching them, if, indeed, they had not been already indicated by common sense. Of all the arts, architecture calls for the greatest exercise of thought; yet, strangely enough, this is the very element that is most wanting in it at the present day. All successful buildings must express an idea; they must mean something. The architecture of previous times rests on this basis, and those structures which give the most evidence of the fact are the most successful. Even in the distorted view of our day those buildings which depart from this position are the most condemned. Yet the very people who censure such lack of judgment by their ancestors do not hesitate to follow in their footsteps and produce architectural monstrosities that should never have been conceived in an intelligent age. The very rudest of African savages is fully aware of this important fact, and keeps it well in mind in building such structures as the simple needs of his life and his primitive ideas require. Thus, for example, he will build a very different edifice for a granary than he will to live in. It has been reserved for the

nineteenth century, with its great wealth, its boundless resources, and its extensive and diversified knowledge, to cast this cardinal principle to one side. Savages may, indeed, be foolish enough to build houses which exactly express the life of their builders and answer every requirement of their primitive form of existence, but we of this time are above such petty expedients, and can well afford to conform our lives to our architecture. We do not need to make our architecture conform to ourselves.

Judging from the monuments of our time, the view that architecture is not ornamentation but construction, not for beauty but for utility, not for an elaborate exterior but for a well-devised interior, not for something pleasing to look at, but for something to live in or to be put to a certain well-defined purpose, is not one that has any considerable support. A glance at a few of the chief points of architectural history will show how true this is, and to what an extent it underlies all that is good in the building art. It is characteristic of the earliest stages of society, those in which architecture had its birth, that nothing is built without a reason. Then people had too few ideas, were provided with too limited means, to be able, on the one hand, to think of unnecessary erections, or, on the other, to do more than was called for by absolute necessity. Architecture was barren of ornament, and had a crudeness that is almost repulsive to modern eyes; but, nevertheless, primitive buildings answered their purpose, as a rule, much more satisfactorily than many later ones.

Illustrations of structures in which use, not beauty, is the central idea, are to be found among the masters of art in antiquity. The Egyptians, Assyrians, Greeks, Romans, all followed this leading idea. There are, indeed, instances where the folly of a wealthy tyrant has produced an overloading of ornament, an unnecessary multiplication of details, and a striving after effect has led to the employment of bad methods; but these exceptions do not disprove the rule. On the contrary, these very structures are censured for their violation of this fundamental principle, and it is those in which it is adhered to most closely that excite our admiration and esteem.

Utility, then, being the first element of successful architecture, it follows that the structure of buildings varies according to the use to which they are to be put. This proposition is self-evident, and expresses only ordinary common sense. It would scarcely call for demonstration, were it not for the fact that many modern buildings are constructed on the basis that, if they look well, whether the outward form is suitable or not for the purpose for which they are intended, or whether the exterior expresses the interior in any way, all has been done that is required. A very different state of affairs existed in the past. The ancient Egyp-

tians, for example, adopted a totally different style of architecture for their temples or palaces than they did for their dwellings. The former were of stone, and of a massive method of building that was intended to withstand the wear and tear of ages; the latter were of wood or brick, constructed in a light manner, and without much concern as to their durability. The Romans supply another illustration of the same fact. These people were unquestionably the greatest builders the world has seen, and the methods they employed can properly serve as a guide for later usage. Much of their architecture, judged by the pure standard of the Greek, on which it largely rested, is bad from an æsthetic point of view, and not a little of their construction was devised on methods that can not always be approved of; but, apart from this, the buildings of the Romans offer many interesting examples of the application of idea to structure, and the importance of utility over mere questions of art.

It has been remarked that in ancient Rome no one ever had a doubt as to the use to which any building was put or what it was; and, in truth, great as was the variety of Roman buildings, their forms were so many, their plans so varied and so well expressed in the structure, that there never could have been room for the smallest doubt on the subject. The temple differed from the basilica, the basilica from the amphitheatre, the amphitheatre from the palace, the palace from the baths. In a word, each class of buildings had its own form, its own plan, which was based, not on some fancy of the architect, not on some individual caprice, not on some mistaken idea of the beautiful, but on the single thought that if the building answered its purpose it was satisfactory and accomplished all that was to be expected of it. In the golden age of the Roman Empire enormous sums of money were spent in adorning the capital and chief cities with public works—buildings not only for the emperor himself but for public and state use as well. The display of wealth and luxury was lavish in the extreme; ornament and decoration were to be seen in every available place in the greatest profusion; yet in the midst of all this gorgeousness the Roman architect never forgot the destination of the building. If a complicated structure, like a bath, was needed, there was no limit to the extent to which the plan was elaborated; if a simple edifice was required, such as a basilica, there was no multiplication of parts for external effect, but simply the large hall and the necessary rooms. The ornament was frequently profuse and much overdone, but the architecture proper, the structure itself, the plan, the essential part, was never anything else than what it was intended to be.

There is nothing astonishing in this method, which is only the application of common sense to art and the subordination of orna-

ment to the requirements of the time. It would not call for comment were it not that modern builders so persistently refuse to recognize it as a fundamental principle in building. Nowadays, when an architect designs a building, he is satisfied he has done all he is required to do if it looks well. If the builder of a house wants a stairway or a window in a particular place because he thinks it will be more convenient, and thereby interferes with the symmetry of the drawing that is submitted for his inspection, he is argued out of it because, forsooth, it will destroy this carefully prepared symmetry or spoil some technical gimcrack that the architect regards as his chief device; and if by chance the owner carries the day, the architect retires in chagrin, and despairs of his art ever making good progress.

No greater harm is done to the true advancement of architecture than this insistence that exterior effect is the sole end to be desired. More than any other cause it has operated to depress the art, and helped to make people question the utility of intrusting their interests to the architects. It has spread abroad the impression that these gentlemen, who might be very useful, are unnecessary luxuries, and that a much more comfortable dwelling can be built by indicating one's own desires and following one's own suggestions and views as to convenience, than by paying large sums for "pretty" façades that very likely conceal more discomfort and dissatisfaction than the most vivid imagination can conceive of in a twelvemonth. As a natural result there is a popular skepticism as to the value of professional services that not only hinders the development of a modern architecture, but does serious injury to the profession as well. Yet architects have only themselves to thank for this condition of things, and they can never hope to win the confidence of the public until they have laid aside their so-called art, and begun to design structures with the sole end of making them answer the requirements for which they are intended.

The most remarkable movement in modern architecture has been the Gothic revival, in the midst of which we are living. It has resulted in the wholesale approval of all that is mediæval, and all that bears the impress of Gothic art. It is important, not only as showing an interest in the really good work of previous times, but as indicating an appreciation for an art that is based on common sense and the adaptation of ends to means. Gothic architecture is nothing if not sensible. It originated in a time in the world's history when building was at its lowest ebb. The founders of Gothic art were possessed of limited means; they were without wealth, and their general knowledge was of the scantiest. The magnificent structures to which the Romans had been accustomed were impossible to them. Every stone counted, every item

of expenditure was rigorously scrutinized and, if not essential, cast to one side as a luxury that was unnecessary and could not be afforded. It followed, therefore, that a Gothic building had no superfluous parts, no erections intended solely for effect, nothing that was not absolutely essential. There was no unnecessary multiplication of detail; there was no attempt at a refined balance of parts or at symmetry.

Symmetrical building is the greatest bugbear that besets the modern architect, and has done more to throw him into disrepute than any other invention of the craft. The making of two parts of a building the same, whether their use was identical or not, is a very recent invention, and, though practiced by the Romans to a limited extent, was almost unknown prior to the fourteenth century. Every style has permitted more or less irregularity, according as the plan required it, and it was not until the Renaissance—a movement that is responsible for more architectural sins than is generally supposed—that the astonishing idea was presented to the world that all the corresponding parts of a building must be alike. The Egyptians, Assyrians, Greeks, Romans, and the architects of mediæval Europe, were all equally free and unsymmetrical in their designs and their methods. Even the Greeks, who produced more symmetrical buildings than any other people of antiquity, varied their designs to suit circumstances. It is needless to multiply examples, and it is sufficient to point out that this freedom from restraint, this ability to vary the design, is one of the chief glories of Gothic architecture, and helps make it applicable to the varied requirements of modern life.

Yet this very freedom militates against the use of Gothic, and is one of the reasons why it is not as satisfactory for modern requirements as it ought to be. The capability for constant variation permits the architect to compose designs of not a little beauty and almost infinite variety, which so fascinate him that in his search for a pleasing façade he forgets that the external appearance of his building may not conform to the best plan or the greatest convenience. The new Law Courts in London furnish a remarkable illustration of this. These buildings were designed by one of the leaders of the Gothic movement—Sir George Gilbert Scott—a man who was thoroughly imbued with the Gothic spirit, and who devoted his life to the propagation of Gothic forms. Yet he so far overlooked the prime element of Gothic architecture—utility—that the completed structures have been found totally unsuited for the purposes for which they were intended. It can not be wondered at that, when those to whom we look for guidance fail, there should be so many smaller failures by those not so well equipped, and who can not, therefore, be expected to have the same knowledge. There can be no surprise that there has been a revul-

sion against Gothic art, which bids fair to reach such proportions as to once more drive it out of use.

There is nothing more misunderstood at the present day than Gothic architecture. It is popularly supposed that if a building has a sloping roof, and is plentifully adorned with buttresses, pinnacles, towers, arches, balconies, dormers, and similar things, it is in the correct form of that order. Gothic architecture is, indeed, characterized by all these objects in one shape or another; but the mere placing of them in juxtaposition no more produces it than does the placing alongside of each other water, flour, and yeast make bread. It is the proper and due combination of these constituents that produces the desired result in each case. Gothic buildings have sloping roofs, because the style originated in a part of the world where the rainfall was abundant, and some device was needed to throw off the water. They have arched openings, because practical experiments in building have demonstrated that they are the most economic and safe form to use. They have buttresses and pinnacles, because they were necessary to resist the thrust of a vaulted roof. In the best Gothic not one of these forms was used unless it was an essential part of the construction. The moment one is applied to a building for ornamental purposes, or for any object other than as a necessity to its statical condition, the structure ceases to be Gothic and becomes a hybrid without a name.

Gothic architecture never employed a form that was not necessary. In this respect it offers a striking contrast to what is now called modern Gothic, which consists in applying ornament to surfaces and giving them forms which have no real meaning of their own, and are nothing more than ornamentation. A building does not become Gothic simply because it has a gable or a carved doorframe; the principle, the cause which made them Gothic in the old form, is wanting, because from parts of the structure they have become mere pieces of decoration. Gothic architecture is expressed by many forms; but its true character lies not in them, but in the application of sound constructive methods to the science of building. It is this principle that gives it a glory of its own, and it is the violation of this fundamental element which renders the Gothic architecture of the present day so unsatisfactory and so un-Gothic in spirit.

But there is another element of Gothic architecture that calls for consideration, and that is, that notwithstanding it could be varied and each part made to be exactly what it was intended to be without regard to the total effect, the results are perfectly satisfactory from an æsthetic standpoint. It shows, in a conclusive manner, that a building can be erected with the sole aim of being useful and answering exactly the requirements for which it is

designed, and at the same time be of sufficient beauty to call forth the commendation of future ages. In other words, utility in architecture is not synonymous with ugliness, nor does it follow that, because a structure is essentially useful, it is any the less beautiful. This fact is of great importance, because many modern builders have the singular idea that beauty of form and utility of structure are mutually antagonistic. The Gothic builders, for instance, employed the grandest forms and the most ambitious designs for their cathedrals; but, when they set about building a dwelling or a warehouse, kept their designs well within the limits for which they were intended. They used the same shapes, the same details, the same ideas, it is true; but the application of them is different in a dwelling from that in a church. Modern architects, on the contrary, do not hesitate to apply forms and methods that are peculiarly ecclesiastical, and which have no significance in any other connection, to domestic work; and it is no unusual thing to-day to see a castle turret decorating the corner of a thoroughfare, or a church doorway leading into a financial institution. A confusion naturally ensues as to the use of the structure, and the average spectator is frequently at a loss to know for what purpose a particular building is intended. In mediæval times such a condition would have been impossible, because then the idea that intention was the chief thing to be expressed in a structure was so firmly imbedded that any other process would never have been thought of.

It goes without saying that, if an adherence to this principle produced satisfactory results in past times, the same methods would bring about equally good ones at the present day. And yet the thought is so far forgotten as to be seldom practiced. Not all the architecture of the present time is bad, but so much of it is, that no opportunity should be neglected of hastening a reform. Our political thought is directed toward reform; we have ballot reform, civil-service reform, tariff reform, and very shortly the art world must have architectural reform, or it will be impossible to live in our houses. In place of use, we are given ornament; in place of intention, we have design. On every side buildings are criticised for their appearance, and are generally found unsatisfactory—a state of affairs that can be directly traced to their lack of ideas. Music is flat and insipid just so far as ideas are absent from it, and the same may be said of architecture. There are unrivaled opportunities for good work and plenty of it in this country, and yet there is a constant cry of dissatisfaction with the products of our architectural labor. Government architecture is as bad as that produced under private auspices. In ancient Rome it was the government's work that was the best done and has survived the longest. In the nineteenth century it is the private

work that reaches a respectable age, while that done by the government undergoes a rapid decay. The difference between the ancient and the modern method is enormous, and it needs no guide to tell which is the better. In our time, in our country at least, government architecture is considered of more importance for its effect on the "boys" than for any direct relation to the progress of art. There is no limit to the expenditures that are made on our large public buildings, but they are no sooner completed than extensive repairs are necessary that not infrequently amount to as much as the original cost.

Nothing could be worse than this, yet it is happening every day. Our streets are lined with hideous structures and comfortless dwellings. Lighting and ventilation, plumbing and heating, and all the requirements of our daily life, are sunk into subordinate positions beside the questions of external effect and the support of a large number of political hangers-on whose interest in architecture terminates with the job. It is evident that this can not be continued indefinitely. Sooner or later there will come a revulsion in public feeling, and an insistence that our architecture shall express our civilization in its fullest development, regardless of designs or exteriors. The direction in which we are working is essentially bad; and it is manifest that, if they did things better in past time, when utility was the prime consideration, the sooner we return to primitive methods the better it will be. It is a lasting disgrace to our culture that the Bushman and the Hottentot, the Indian and the Patagonian have ideas in architecture that put our own attempts to the blush and will render us a laughing stock to posterity. The instincts of animals, even, teach them ways and means of construction that are far in advance of the methods of the men of the nineteenth century. Did not the wise man say go to the ant and consider her way and be wise?

The architecture of the past teaches us many facts of interest and value, but none more important than this, that a building must express an idea. It must not seem to be what it is, but be it, without any uncertainty or doubt. In the structures now going up around us, in this land as well as in other lands, this essential element is apt to be found wanting. There are too many buildings that need repairs and alterations before they can be occupied. There are too many structures erected for external effect, without due regard to the planning and the use to which they are to be put. There is too much drawing of pretty plans and elevations on paper, without proper attention to structural requirements. There is too much haste, too much careless management, too much poor construction, too much attention to detail, too much bad taste. As a result, our buildings are bad in conception and execrable in execution. We must not condemn a build-

ing for some unpleasant detail, some crude idea. Nothing could be less proper; no building, no matter what its form, should be condemned until we know its purpose, and whether it fills it or not. The very fact that it is necessary to speak of "knowing the purpose" of a building shows how thoroughly the art has degenerated.

EDUCATION AND CRIME.

By Rev. A. W. GOULD.

IN the January number of The Popular Science Monthly there was an article by Benjamin Reece on Public Schools as affecting Crime and Vice. In that article Mr. Reece mentions the fact that "in the decade ending with 1880, population having increased thirty per cent and illiteracy only ten per cent, the number of criminals present the alarming increase of eighty-two per cent." And he asks: "Can it be possible that with greater educational facilities there is to be increased crime? Perish the thought! Yet if the instruction of our common schools subdues the tendency to crime, why is it that the ratio of prisoners, being one in every 3,442 in 1850, rose to one in every 1,647 in 1860, one in 1,021 in 1870, and one in 837 in 1880?" He tells us further that "the illiterates of the United States comprise seventeen per cent of the total population. . . . The general average of illiteracy is exceeded by every one of the original slave States with the exception of Missouri, but the average ratio of the mentally and morally unsound is only reached in the State of Maryland. South Carolina, which shows the highest percentage of illiterates, presents the lowest average of any State in the Union as regards insanity and crime"; and his conclusion is that "our condition of decreasing illiteracy and increasing crime" means that "in the adjustment of our schools we have gone too far in our aim for material advancement and development of wealth, and that we are correspondingly losing in the direction of moral growth and culture."

In other words, he thinks that the United States census proves that the increase of prisoners in our prisons is the result of the increase of pupils in our schools. And as I find that these "novel and threatening facts" have aroused some apprehension among those interested in our public-school system, it seems to me desirable that some one should point out the figures in our census which seriously modify, if not wholly destroy, Mr. Reece's alarming inference that our public schools are nurseries of crime.

Figures, like Bible-texts, may not lie, but they can be made to prove almost anything; and it would not be difficult to establish, by our census figures, the exact opposite of Mr. Reece's conclu-

sion, if we may be allowed to use the same reasoning that he does. For his statistics only show that crime and education are both increasing. But that does not prove that the increase in education is the cause of the increase in crime. Diseases have increased during the past half-century, and so has medical skill; but that does not prove that the one increase was caused by the other. Perhaps the increase of diseases would have been far greater had it not been for the increase in the power to cope with them. So education may, for aught Mr. Reece's statistics prove, be the only thing that prevents a still more rapid growth in crime.

The statistics of our last report show that the most enormous strides in developing a criminal class have been taken in those States where ignorance, and not education, most abounds. If we take the ten States that have the largest number of citizens unable to write, we shall find that from 1850 to 1880 the ratio of their prisoners has increased over fivefold, from one in 5,400 to one in 970; from 1860 to 1880 it has grown threefold, or from one in 3,600 to one in 970; while the ten States that have the fewest citizens unable to write have swelled the proportion of their criminals only threefold for the longer period and only fifty per cent for the shorter—the figures being, for 1850 one in 3,100, for 1860 one in 1,500, and for 1880 one in 1,050. So that in the States of greatest illiteracy the relative increase of criminals during the last twenty years has been six times as rapid as in the States of least illiteracy. And if we ask in what classes the most ignorance is to be found, our census tells us that the foreign-born are fifty per cent more illiterate than the natives, and the blacks seven times as illiterate as the whites; and our census tells us further that the foreign-born furnish one hundred per cent more than their share of criminals, and the blacks one hundred and fifty per cent more than their share.

Do not these facts prove that the advance in crime is the result not of education but of the absence of education? We might think so, if figures had not that reprehensible habit of being all things to all men. Therefore, we may find, upon a more careful examination, that there is some other cause than ignorance for this rapid growth of our prison population in certain parts of our country. If I am not mistaken, there are several such causes, some of them entirely independent of the change in the illiteracy of the nation. One of them lies in the transition from an unsettled condition to a settled condition on our constantly advancing frontier: another is in the change from slavery in the South; and, a third is in the gradual elevation of the standard of human conduct, making crimes of actions that had been only lawful escapades in earlier times.

The first cause comes out clearly if we compare the ten States

that were on the frontier in 1850 with ten older States—the New England and Middle States, for instance. In the former the ratio of criminals has been multiplied four or five times during the past thirty years, while in the latter it has only doubled, rising from 244 to 1,148 prisoners in a million inhabitants on the frontier, and from 450 to 1,074 on the seaboard. Of course, it is obvious that in a new country there will be a certain amount of lawless conduct unpunished at first, before sheriffs, courts, and jails are in running order. But the rapid increase in the proportion of criminals, as the State grows older, does not mean more crime; it often means less. The evil-doers are arrested and sentenced, and so get into our prisons and our census; and then we are told that crime is increasing. Kansas had only 289 prisoners to each million of inhabitants in the decade before the rebellion, while it had 1,300 to the same number in the last report; yet every one knows that this State was a far more dangerous place at the earlier time than now. Colorado had only 477 offenders per million at its first census, in 1870, but in 1880 it reported 1,950, a gain of nearly fivefold in a single decade; while on the other hand the older States, like New Hampshire and Connecticut, showed an actual decrease in percentage during these periods.

But the transition from slavery to freedom was a far more efficient cause in swelling the ratio of this class. If we compare ten of the original slave States with our ten New England and Middle States, we shall find that the increase in crime in the slave States has been three or four times as great as in the free States. The former had, for each million of population, only 161 criminals in 1850, and 240 the next decade. But in 1870 they had 829, and in 1880 1,166. This was an increase of sevenfold, while the free States only a little more than doubled their criminal element.

That this was the result of the emancipation is seen in many ways. The sudden leap shows it between the decade before and after the war, or between 1860 and 1880, if 1870 be thought too near the contest to be a fair test. Those twenty years gave a gain of fivefold in the proportion of prisoners of the Southern States, while the Northern States showed a gain of less than forty per cent. Single instances reveal it still more clearly. Mississippi sprang from 67 to 1,158 criminals in a million inhabitants, and other States of the South show nearly as great a gain; while New York and Massachusetts actually declined in their criminal percentage during that time, as did some other Northern States.

The explanation is obvious. Before the war the negroes were slaves, and nearly all their offenses were punished by their masters, so that the State had no occasion to imprison them. But now, from five to ten times as many blacks as whites, in proportion to their numbers, are found in the jails or chain-gangs of the South.

And when we remember that the greatest illiteracy is to be found in the former slave States, we see that the increase of the criminal ratio in the South may not be due wholly to ignorance, in spite of census figures. The ignorance and the crime were both there before the criminals were locked up and counted in the census.

One might, indeed, claim that the lessened ignorance had much to do with revealing this criminal element and imprisoning it. And this brings us to our third cause of the increased ratio of crime. The gradual elevation in the standard of life, and the intervention of the courts in cases which were formerly decided by the bullet or the knife, occasions a rapid increase in the official number of criminals.

Drunkenness, I suppose, was not a crime anywhere in our land half a century ago. Now drunkenness and disorderly conduct form one tenth of all the crime of the country. And naturally the restraint of these offenders will be most complete in the most orderly and educated parts of our land. Accordingly, we find that the ten educated States show a proportion of imprisonments for these offenses tenfold greater than the uneducated States do. The one has 2,865 and the other only 198 in a population three fourths as large. And the educated States record three times as many prisoners as the uneducated States for assault and battery and simple assault. If any one wishes to prove from the census that education is a failure, he could find no stronger facts than these—a tenfold larger share of drunkenness and a threefold larger share of violence in the States where men can read and write than in the States where they can not.

But, of course, no one thinks that the South is more quiet, orderly, and innocent than the North. No one believes that there was not a single case of drunkenness or disorder in all Alabama and Arkansas in 1880, and only a score of cases of assault, while Massachusetts, with a less population, had 597 cases of drunkenness and disorder and 337 cases of assault; yet this is what the census tells us. The natural interpretation must be, that drunkenness and violence are not punished by imprisonment in certain States, while they are in others, and the States that punish least are most illiterate. This interpretation is amply confirmed by the census itself. Though education shows three times the violence that ignorance does, yet ignorance perpetrates three times as many murders as education, and that, too, while two or three of the educated States imprison the murderer for life, and so swell the number, and while the illiterate States do not even think of arresting some murderers, and often acquit others who are most notoriously guilty. It was only last year that all the land heard that a certain Dr. McDow, a married man of Charleston, S. C., murdered a Captain Dawson, simply because he saved a girl whom the doctor was trying to ruin. No

one denied the murder, yet the papers tell us that the doctor was triumphantly acquitted and honored by the society of the city as a hero, instead of being counted by the census as a criminal.

And it is only in a high state of society that offenses against virtue cease to be either overlooked or avenged by violence. In this very State of South Carolina there are only four such offenders reported in prison, while Michigan has forty and Massachusetts over two hundred. The latter State, indeed, has more than all the illiterate States together. Yet, are we to think that Michigan is ten times as sinful as South Carolina, or that Massachusetts has more vice than all the ignorant States combined? McDow's case shows that such vice exists, and how it is regarded. A clergyman of the South recently asserted in the Nation—and he has not been contradicted—that only a small minority of the colored women were chaste; yet the census makes them far more virtuous than their white sisters of the North. We do, indeed, hear quite frequently of negroes being lynched for such offenses, but they obviously do not count in the census.

Therefore, though education may swell the list of criminals, there are reasons for thinking that more education and not less is what certain parts of our country need. They need more prisoners. If more men were punished for drunkenness and violence, there would be less murder. If more murderers were executed instead of being lynched or lionized, there would be less violence. It is by checking the lesser offenses that the greater offenses are avoided, though the prisons are filled thereby. And as civilization improves in the South, no doubt the proportion of men in prison will increase, at least for the present; and the whole country can not rise in its standard of moral conduct without increasing the law-breakers, especially while we have to assimilate each year such a large and often lawless element from other lands.

One of the results of raising the mass to a higher moral level is, that individuals here and there drop out; and the higher we are raised the more will drop, and this will continue till those incapable of self-control have disappeared. It is only among savages—where there is no chance to drop, because all are on the ground—that we find no criminals or paupers. And Mr. Reece actually sighs for the "perfect order" found associated with the "densest ignorance" among the cave-dwelling Veddahs and other tribes. Possibly we might attain this "perfect order" if we would imitate the savages in leading a savage life. But that would be a pretty dear price to pay for such order as savages secure.

Most of us prefer civilization with all its drawbacks. We prefer to see our country settled, though we know that jails will be

built and occupied. The very convenience of city life is paid for by added crime. The disorder that might be allowed in a wilderness among savages can not be tolerated in a crowded metropolis among civilized people. The ten States that have the largest cities punish fifty per cent more violence and sixty per cent more drunkenness than their share, though they have twenty per cent less than their proportion of murders. Petty crimes come from civilization, great crimes from barbarism. But among barbarians great crimes are called virtues, and petty crimes are unknown or unnoted.

I think, then, we need not fear that universal education is to bring us universal crime. We want more and better education. Of course, it is not the mere ability to read and write that is to save a man from prison. He must learn self-control and acquire a loftier standard of life. Mr. Reece dwells much upon the fact that a large percentage of our criminals can read and write. But that does not prove that their education made them criminals. I dare say a still larger percentage of them can see, yet it was not their ability to see that made them criminals. The densest ignorance may, like total blindness, keep men from crime; but we do not propose to put out our eyes of either mind or body. We will have men learn to see better, morally and physically. It is imperfect education that has brought men to prison, as we see from the constant relation of our criminal class to our illiterate classes. They may, indeed, have some sort of an education, but the vast majority of them are ignorant themselves, and have ignorant kindred and associates; and to be ignorant amid the civilization of to-day is to be jealous and bitter and rebellious.

The very fact that Mr. Reece cites to prove his thesis, that ignorance is innocence and knowledge crime, disproves it most completely. South Carolina, he says, has the highest percentage of illiteracy and the lowest of crime; but, if he had taken one glance below the surface, he would have seen a fact far more "novel and threatening" than any he discovered. Out of the 626 criminals of South Carolina, 570 are black and only 56 are white. Why are there ten times as many blacks as whites in jail, when they constitute only three fifths of the population? The only answer the census gives is in the fact that they are three times as illiterate as the whites. So that the very State summoned to prove that ignorance is exemption from crime, has ten elevenths of its criminals from the most ignorant class in the country. But perhaps Mr. Reece thinks that their ignorance is not quite dense enough, as one in four can still write. They certainly have not yet reached the point where ignorance is bliss.

THE AFFIRMATIVE SIDE OF AGNOSTICISM.

By JAMES A. SKILTON.

WITH LETTERS FROM HERBERT SPENCER, PROF. HUXLEY, AND DR. LYMAN ABBOTT.

IN the sacred literature of the Christian Church a word appears that to its founder and to his immediate followers evidently had a deep significance, the nature of which was at least partially concealed from his later followers, and is still concealed from those of the present day, through admitted mistranslation.

Standing on Mars' Hill and speaking to the men of Athens, Paul affirmed that in all things they were "too God-*fearing*."* Whereupon he proceeded to declare and make known unto them the God whom they worshiped as the Unknown or Agnostic God. In so doing he spoke of a God, the Lord of heaven and earth, who made the world and all things therein; who dwelt not in temples made with hands; who needed nothing, seeing he was the giver of life, breath, and all things; who had made of one blood all nations of men; and who had determined the times before appointed and the bounds of their habitation. He declared that they should seek the Lord *if haply they might feel after him and find him*, though he was constantly at hand, and the one in whom they lived and moved and had their being. He closed with a strongly put antithesis in which, without declaring divine condemnation of their agnosticism, which he said God "winked at," and they might therefore tolerate, he urged them to obey the command of God—"metanoein"—to practice metanosticism. This word has been translated to mean "repent." It is hardly sufficient to say that that translation is etymologically inadequate; the history of the Christian Church also, for eighteen centuries, proves it to be practically so. Paul evidently found in the word "metanoein" the open door of a temple in which a God-fearing worship might be exchanged for a God-loving worship. The history of his own life shows that his personal conversion was a metanostic process through which a defective external sight was exchanged for a clear insight, revealed to him as with a lightning-flash at midnight, wherein he instantly saw "the world and all things therein" in an entirely new aspect.

The question, then, indirectly presented for the consideration of the entire Christian Church, in the following correspondence, is, Whether it should adopt the word actually used by Paul, with its large meaning, either alone, as a step forward, and to restore to the sacred record and to the working power of the Church the

* The word he uses is "deisidaimonesterous," and includes the idea of devil-fearing.

true meaning of the word used by Paul, but first used by the one whom he preached and followed, as the central and supreme word in his system of salvation for the world and for mankind; or, co-operatively with science and philosophy, for the purpose of securing their powerful aid for its work in the world?

CORRESPONDENCE.

NEW YORK, *November 20, 1889.*

HERBERT SPENCER, ESQ.

DEAR SIR: I beg the privilege of presenting hereby, for your consideration and determination, a question of seemingly universal importance, that has arisen in the course of our work in the Brooklyn Ethical Association.

As far as possible I have sought to so present it as to limit your labors therein to yea, yea, or nay, nay.

The question relates to the selection and adoption of words for general use in the new philosophy, and as substitutes for the words agnostic and agnosticism, to express the affirmative side of the agnostic conception.

As a result of our experience of nearly two years in attempting to popularize evolution views, we find that just there our greatest obstacle is to be found, and our time and labor are most occupied and consumed, and increasingly so as we approach the popular mass.

The object of this communication is to propose as such affirmative substitutes the words metagnosticism and metagnostic, or metanosticism and metanostic, and to ask therefor your own approval and also that of Prof. Huxley—in concert, if possible.

My own view is that the new or substitute words involve no surrender or concession, but, on the contrary, if adopted would mark an advance in the nomenclature of the agnostic philosophy.

The accompanying statement was made by me as part of the discussion following the reading of the essay of Dr. Lewis G. Janes, on The Scope and Principles of the Evolution Philosophy, the first of the current series of the Brooklyn Ethical Association, on the evening of October 13, 1889, and it will explain itself.

I also hand you herewith a list of words and their definitions, derived or derivable from the Greek verbs *gignoskein* and *noein*, in composition with the preposition *meta*, the imperative form of which was used, according to the Greek Testament, by John the Baptist and Jesus Christ, in that passage in which they are made in the Douay Bible to say, "Do penance, for the kingdom of heaven is at hand," following the Latin Vulgate; and in King James's and later English versions, "Repent, for the kingdom of heaven is at hand."

These definitions of these words were prepared more than a year ago, at the special written request of Rev. Lyman Abbott, D. D., the pastor of Plymouth Church, Brooklyn; and the list is a copy of the first rough draft or study made in compliance with that request, but, for reasons unnecessary to explain here, has not yet been presented to him. For what use these definitions were intended by him I am neither authorized nor prepared to positively state. Dr. Abbott is in special charge of theology, liturgics, and ecclesiastical history, as editorial contributor, under the chief editorship of Prof. William D. Whitney, in the preparation of The Century Dictionary, which is an encyclopedic dictionary of the English language, now in course of publication by the Century Company, the first volume of which now lies before me. . . . In Volume I the words agnostic and agnosticism are defined at length, with references to Huxley, Romanes, and Cobbe, and to the source of the suggestion of the same by Prof. Huxley in the mention by St. Paul of the altar he had seen erected by the Athenians to the Unknown God.*

As I have previously informed you, early in his pastorship of Plymouth Church, Dr. Abbott declared his belief in the evolution philosophy, and his high sense of the value of its co-operation in the religious work of the future. He is also the editor of The Christian Union, the leading liberal religious newspaper in America. His position as such may be stated to be evangelical-liberal, or conservative-progressive, with the promise of moving faster and further, as soon as circumstances permit. Practically, things are in a ferment in all religious denominations in America at this time; or, to speak more accurately, we seem to be entering a new constructive period, and one which furnishes agnosticism and evolution their great religious opportunity.

In the statement referred to I have used the words metagnostic and metagnosticism to preserve or make parallelism in form with the words agnostic and agnosticism, to which the public eye and ear have now become accustomed, and to the better present the expressive antithesis involved therein. I am, however, fully aware that a word-form and meaning directly derived from the word metanoeite (metanoeo), which is the actual word placed in the mouth of Christ by and through the Greek original, would have certain great advantages. Prominent among them would be the ever-present evidence it would furnish that in the gospel, as actually preached by Christ and his immediate contemporaries and handed down to us, so far as we know it, the human mind was to occupy the leading place, to be elevated, and

* The authority of the Century Dictionary for this erroneous explanation of Prof. Huxley's derivation of the word "agnostic" (see letter from Prof. Huxley) was the New English Dictionary.

not degraded and disfranchised, as it has been by his alleged followers for ages past. Not only in this respect, as it seems to me, would the adoption of such a word bring science and philosophy into harmony with the true religion of Christ and nature, but it would also compel the beginning of a change in organized Christianity that would eventually bring it into complete harmony with them.

Whether the best word is metagnostic, metanostic, metagnosticism, or metanosticism, or some other form derivable directly or more remotely from the root *nous, mind*, is to me a question of minor importance. I would select that which, on the whole, is the truest and best, for the purpose of bringing about the desired reconciliation of religious with other forms of truth, even if it were necessary to manufacture the form for the occasion; and this, it seems to me, we are at liberty to do, since, strange as it may seem, while we have in our language and in frequent use all the other words derived from the kindred Greek words, the most important words of all, and the supreme words of the religion of the English race (metanoeite and metanoia), have never, apparently, up to this time, been transferred to or adopted into the English language.

The suggestion is based upon the proposition that the words to be adopted do and shall express, cover, or include the affirmative side of the terms agnostic and agnosticism. The selection of the proper forms I leave entirely to you, in co-operation with Prof. Huxley, if you approve the suggestion and think the matter worthy your and his attention.

Certainly it must, it seems to me, be considered a desirable thing to find words of affirmative import to designate the affirmative meaning hidden under the terms in present use, since it must seemingly tend to foreclose further argument and confusion on that branch of the subject.

I inclose copies of these papers to be addressed and forwarded to Prof. Huxley, if that course meets your approval.

My own plan would be, on receipt of the approval of yourself and Prof. Huxley, to bring the matter before the public, through our Association, at one of the meetings of the series now well commenced for the season, through The Popular Science Monthly, and by other means within my present reach. I am confident that recognition in the Century Dictionary would follow, and that a great impulse would be given to the new philosophy, to what would practically be a new or reformed Christian religion, in harmony with human intelligence and progress, with the express word and thought of the founder of Christianity, and calculated to combine them in the interests of the world and the race.

Very respectfully yours, JAMES A. SKILTON.

The "list" referred to included the words meta(g)nostic, nouns and adjective, meta(g)nosticism, meta(g)noiology, and meta(g)nosis. The definitions given were made approximately parallel with the definitions of the words diagnostic, prognostic, diagnosis, prognosis, etc., as found in Webster, and need not be here presented.

Monday, November 25th.

P. S.—The foregoing letter was complete on Saturday last. On Sunday, the 24th inst., by a coincidence that seems to me not to be a mere coincidence, Dr. Abbott, without any knowledge of this correspondence or my intentions, took for his subject the sermon of Paul on Mars' Hill, for the purpose of dealing with the "new doctrine" and "new thing" involved in the "new theology" now agitating the American churches. He referred to your position and that of Prof. Huxley, quoted from your writings, and practically placed himself not only in line with agnosticism as explained by you, but so near to the position I have given him in these pages that the next step must have brought out the new word. His expressed thought implied it, and I had prepared myself to hear it, when he suddenly brought his sermon to a close. I feel myself, therefore, once more justified in my statements, and am all the more anxious to use, or rather to have you use, the present opportunity. I will ask him to print the sermon, that I may send it to you in confirmation.* J. A. S.

STATEMENT.

Dr. Janes having unexpectedly and without suggestion of mine used my name in connection with the term "metagnosticism," I feel compelled to make my use of it as clear as possible at once, without waiting another occasion.

The doctor chooses his words with exceeding skill and care. He says that he will endeavor, in defining philosophical agnosticism, to show that "in every department of scientific, historical, and true philosophic investigation, indeed, it is consistent and coincident with the meta-gnosticism of his friend Mr. Skilton." †

As so limited—to the definition of philosophical agnosticism—the statement and the subsequent showing are both entirely satisfactory. But the limitation is not so.

As adopted and used by me, the term meta-gnosticism has a much larger meaning, and has an important bearing not only upon science, history, and philosophy, but also upon and in re-

* The substance of the sermon is embodied in an article in the Forum for April, 1890.

† For a discussion of meta(g)nosticism in relation to the evolution of society, see Evolution—Popular Lectures and Discussions, before the Brooklyn Ethical Association, pp. 216-227.

ligion, meaning the religion of our civilization, as well as the religion of evolution and the future.

The evidence is abundant that even in the domains of science and philosophy the word agnosticism does not and can not express in full the idea or system for which it stands representative. Mr. Huxley, the inventor of it, is, as we all know, in a state of constant warfare over it; and as to Mr. Spencer, it is sufficient to refer to his controversy with Frederic Harrison and his "x^2" as the appropriate symbol "for the religion of the Infinite Unknowable."

With both of these men—the acknowledged leaders among agnostics—and with all their followers, the trouble is that at present they are compelled to seek to accomplish the practically impossible by attempting to read a positive and affirmative meaning into a word that is and can be only indefinite and negative. And the words meta-gnosticism and meta-gnostic are proposed for the purpose of meeting precisely that difficulty, and for the reason that they are positive and affirmative.

Mr. Huxley really found the word agnostic, or its root, already in use in the Greek language, and borrowed and used it for the want of a better one, little thinking, doubtless, how important it would become. It is believed that the time has now arrived for importing another word, cognate in origin and affirmative in meaning, into our language, if it be found by competent authority to meet the requirements of the case.

In his essay entitled Retrogressive Religion, in reply to Harrison, Spencer says (p. 68, Appletons' edition):

"I might enlarge on the fact that, though the name Agnosticism fitly expresses the confessed inability to know or conceive the nature of the Power manifested through phenomena, it fails to indicate the confessed ability to recognize the existence of that Power as of all things the most certain. I might make clear the contrast between that Comtean Agnosticism which says that 'theology and ontology alike end in the Everlasting No with which Science confronts all their assertions,' and the Agnosticism set forth in First Principles, which, along with its denials, emphatically utters an Everlasting Yes. And I might show in detail that Mr. Harrison is wrong in implying that Agnosticism, as I hold it, is anything more than silent with respect to the question of personality; since, though the attributes of personality, as we know it, can not be conceived by us as attributes of the Unknown Cause of things, yet 'duty requires us neither to affirm nor deny personality,' but 'to submit ourselves with all humility to the established limits of our intelligence' in the conviction that the choice is not 'between personality and something lower than personality,' but 'between personality and some-

thing higher,' and that 'the Ultimate Power is no more representable in terms of human consciousness than human consciousness is representable in terms of a plant's functions.'" And again (p. 66, id.): "Whereas, in common with his teacher Sir William Hamilton, Dean Mansel alleged that our consciousness of the Absolute is merely 'a negation of conceivability'; I have, over a space of ten pages, contended that our consciousness of the Absolute is not negative but positive, and is the one indestructible element of consciousness 'which persists at all times, under all circumstances, and can not cease until consciousness ceases'—have argued that while the Power which transcends phenomena can not be brought within the forms of our finite thought, yet that, as being a necessary datum of every thought, belief in its existence has, among our beliefs, the highest validity of any: is not, as Sir W. Hamilton alleges, a belief with which we are supernaturally 'inspired,' but is a normal deliverance of consciousness."

These quotations are sufficient to show that, as he holds it, there is a positive and affirmative side to the doctrine of the Unknowable, or to agnosticism, as taught by Mr. Spencer; and also that there is occasion for a word or words to express it.

In his article Agnosticism, published in The Popular Science Monthly for April, 1889, Prof. Huxley says:

"Agnosticism, in fact, is not a creed, but a method, the essence of which lies in the rigorous application of a single principle. That principle is of great antiquity; it is as old as Socrates; as old as the writer who said, 'Try all things, hold fast by that which is good'; it is the foundation of the Reformation, which simply illustrated the axiom that every man should be able to give a reason for the faith that is in him; it is the great principle of Descartes; it is the fundamental axiom of modern science. Positively, the principle may be expressed: In matters of the intellect, follow your reason as far as it will take you, without regard to any other consideration. And negatively: In matters of the intellect, do not pretend that conclusions are certain which are not demonstrated or demonstrable. That I take to be the agnostic faith, which, if a man keep whole and undefiled, he shall not be ashamed to look the universe in the face, whatever the future may have in store for him.

"The results of the working out of the agnostic principle will vary according to individual knowledge and capacity, and according to the general condition of science. That which is unproved to-day may be proved, by the help of new discoveries, to-morrow. The only negative fixed points will be those negations which flow from the demonstrable limitation of our faculties. And the only obligation accepted is to have the mind always open to conviction."

In view of such utterances—and of many similar ones in other writings of both Spencer and Huxley—it seems that a positive and affirmative word, or set of words, capable of expressing the agnostic idea, if to be found or framed, would not only be applicable, but would be acceptable to them and fit for the system of thought with which the essay of the evening is concerned.

The words proposed come from the same root as the words gnostic, agnostic, prognostic, and diagnostic.

The root is verbal and affirmative. It means to know; and with the prefix meta, means to know beyond. The noun means beyond-knowledge. Beyond-knowledge may be knowledge "beyond the sphere of sense," and correspond to Spencer's definition of religion, or, as you will, it may refer to all knowledge beyond mere sense-perception, and so include all human knowledge that exceeds that of the brute animal and is derived from or limited by the senses. As for myself, I prefer the total meaning: for then, as the civil engineer uses his base-line and two known angles to measure distances and relations of things beyond the river where he can not go with his tape-line, and the astronomer the distances, actual and relative, of the heavenly bodies, so we may use our actual hither-knowledge for the purpose of dealing with the field of beyond-knowledge—or of the Unknowable—where the senses can give us no direct aid.

As to the appropriateness of the adoption of the proposed words into the English nomenclature of religion, the evidence at hand is still more authoritative and conclusive than in the case of science and philosophy.

In his preceding essay—Religion: A Retrospect and a Prospect—Mr. Spencer begins with these words:

"Unlike the ordinary consciousness, the religious consciousness is concerned with that which lies *beyond the sphere of sense.* A brute thinks only of things which can be touched, seen, heard, tasted, etc.; and the like is true of the untaught child, the deaf-mute, and the lowest savage. But the developing man has thoughts about existences which he regards as usually intangible, inaudible, invisible; and yet which he regards as operative upon him."

If you ask the source from which the proposed words are derived, the reply is that, as to the second form, it is found in the New Testament, and is the supreme word in the messages of John the Baptist, of St. Paul, of Jesus Christ, and of the gospel generally, wherein it is believed truly to have the precise meaning—as shown by the context—of the proposed English word or words under discussion; and that, as to the first form, it is constructed by throwing out the prefix—a—from the word agnosticism, and substituting the prefix—meta.

Prof. Huxley, the inventor of the word agnostic, is said to

ve derived it from St. Paul's mention of the Unknown or Ag-
tic God. The word now suggested is derived from the substi-
e proposed by St. Paul at the same time. While St. Paul did
advise the Athenians to erect an altar to the metanostic God
place of the altar they had erected to the Agnostic God, he
d the word metanoein, and he thereby clearly advocated the
ctice of what we may properly call metanosticism as the alter-
ive and substitute for agnosticism, in connection with religion
l its observances. This he did after expressly declaring the
ence of any divine condemnation of their agnosticism, which
d is said to have "winked at" or overlooked. The strong and
ggestive antithesis made use of by St. Paul has been lost in the
nslations of the language employed by him on that occasion;
t there is no time to enlarge, here and now, upon the fraudu-
t travesty practiced upon mankind for ages by the Church in
nslating the original word so used to mean "do penance" and
epent."

I content myself with asking, What would be the consequences
the candid, common, and proper acceptance and use, through-
t the civilized world, of such a word to express the central
ought of the science, the philosophy, and the religion of our
e and of the ages to come, sanctioned by the high priests of
h of these departments of thought?

I have only a word to add: Without committing this Associa-
n, as its corresponding secretary, or otherwise, or any other
rson but myself, to the proposition, it is my purpose to submit
question of the adoption of the words meta-gnostic and meta-
osticism, or metanostic and metanosticism, as affirmative sub-
tutes for the words agnostic or agnosticism, to Mr. Spencer
l Mr. Huxley, in the hope that, as leaders in modern agnostic
ought, they will see their way clear to their adoption, and
reby supply a link to unite science, philosophy, and a true
ristian religion in behalf of humanity and future ages.

And when their replies are received—if so be—they will be
mmunicated to this Association for its further consideration,
l possibly for its co-operative action.

LETTER OF HERBERT SPENCER.

64 AVENUE ROAD, REGENT'S PARK, LONDON, N. W., *December 22, 1889.*

MY DEAR SIR: I have to thank you for the volume of Evolu-
n lectures, which I received recently. I presumed that they
uld eventually be bound together, and that you would kindly
d me a copy. This, of course, I shall like to keep.

Will you excuse me if I do not go into the matters raised by
ur late letters? I have been made so ill by over-excitement
t until Wednesday last I had not been out for more than a

month, and, though I am now better, I must avoid every mental tax, however small.

I did not receive the journal which you named in your last, containing some matter respecting Dr. Abbott's address (I think it was). Very truly yours,

HERBERT SPENCER.

J. A. SKILTON, Esq.

LETTER OF PROFESSOR HUXLEY.

EASTBOURNE, ENGLAND, *December 10, 1889.*

DEAR SIR: I have read the papers which accompanied your letter of the 25th of November with much attention; but, I regret to say, with the result that I can discover no good ground for the change of nomenclature which you propose. Permit me to trouble you with my reasons for that conclusion:

The term "Agnostic" was not suggested by the passage in the "Acts of the Apostles" in which Paul speaks of an inscription to the "Unknown God" (ἀγνώστῳ θεῷ). It is obvious that the author of that inscription was a theist—I may say an anxious theist—who desired not to offend any God, not known to him, by ignoring the existence of such a deity. The person who erected the altar was, therefore, in the same position as those philosophers who, in modern times, have brought about the apotheosis of ignorance under the name of the "Absolute" or its equivalents.

"Agnostic" came into my mind as a fit antithesis to "Gnostic"—the "Gnostics" being those ancient heretics who professed to know most about those very things of which I am quite sure I know nothing.

"Agnostic," therefore, as the name of a philosophical system is senseless; its import lies in being a confession of ignorance—a warning set up against philosophical and theological phantoms—which was never more needed than at the present time, when the ghost of the "Absolute" slain by my masters Hume and Kant and Hamilton is making its appearance in broad daylight.

Your definition of "metagnosticism" says that it "relates to beyond-knowledge." That is exactly what all the "absolute" philosophers profess the "Absolute" does; and it is precisely that profession which I consider to be futile and mischievous. To my mind science is exact and organized knowledge—neither more nor less. And the knowledge which goes "beyond knowledge" is something which my cognitive faculties do not enable me to apprehend.

The term "Evolution Philosophy" which you employ seems to have different meanings for different people.

For me, evolution is a name for a certain process, the occurrence of which in various groups of things is as nearly demonstrated as any historical event can be. And this, I think, consti-

tutes a fair ground for the expectation that the whole cosmic process will turn out to be one of evolution. The business of philosophy, as I understand it, is, among other things, to arrive at a scientific theory of evolution; but these other things are quite as important as evolution. Philosophy, in fact, should embrace the whole of which the theory of evolution is a part.

Three or four generations of patient workers, cautiously feeling their way by the well-known methods of true science, may bring our posterity within sight of such a philosophy. For the present, while welcoming all attempts to foreshadow it, with due gratitude to their authors, and holding fast by that which is good in them, it is very necessary that we should not confound such scaffoldings with the edifice, the foundations of which are not yet complete. I am, dear sir, yours very faithfully,

T. H. HUXLEY.

JAMES A. SKILTON, Esq.

Prof. Huxley asks that the foregoing letter be made public, on the ground that "there seems to be a good deal of misconception as to the position which now (as always) (he) I hold(s) in respect of current philosophical speculations."

LETTER OF REV. LYMAN ABBOTT, D. D.

PLYMOUTH CHURCH, BROOKLYN, *April 22, 1890.*

MY DEAR MR. SKILTON: There are two distinct questions raised in this correspondence, one an etymological, the other a philosophical one: the first relates to the use of language, the second to the limits of knowledge; the first is as to the meaning of a word, the second as to the powers of the mind.

I. *Metanoëo* is composed of two Greek words, *noëo*, to think, and *meta*. Now *meta*, in composition, appears to imply one of three things: either (1) fellowship, as in *meta-didōmi*, to give to or share *with* another; or (2) exchange, as in *metallassō*, to change *with* another, to exchange; or (3) sequence, as in *meta-melomai*, to care *afterward*, to regret. I can not find that *meta* ever signifies *beyond*. The preposition used for this purpose is *huper*. Thus we have *huperekperissou*, exceeding abundantly, literally *beyond measure*. It would seem, therefore, according to the analogy of language, if the New Testament writers had wished to coin a word to express the idea of knowledge beyond knowledge, the word would have been not *meta-noia*, but *huper-noia*.

It is, however, very clear that the word *repent* does not correctly represent the meaning of the Greek word *meta-noeō*, if we have regard to the etymologies of the two words. *Repent* is strictly to repunish, and this is the idea which the Latin mis-

translation has carried into the New Testament teaching. We have, as a consequence, the popular idea, that the first step in a religious life is self-inflicted punishment for past sin; an idea which gave rise in the middle ages to the elaborate system of voluntary penances, fasting, flagellations, etc., and, more spiritually interpreted, to the still common idea that no man can begin a Christian life without first undergoing what is called a "conviction of sin"—that is, a sense of shame and sorrow more or less poignant because of sin. This misconception—for I am sure that it is a misconception—leads modern revivalists to endeavor, by various rhetorical and dramatic devices, to create such a feeling of sorrow; and would-be converts to endeavor, co-operating with them, to beget in themselves such an experience. And conversion is thought to be, or at least to be attested by, a sudden emotional change from such an experience of regret and remorse to one of peace and joy. This endeavor is scarcely more consistent with the true teaching of the New Testament than the grosser and more material endeavor to inflict self-punishment for sin by penance. The flagellation of the soul is not more scriptural than the flagellation of the body. What the Bible calls on men to do is not to repent—that is, to punish themselves—but to "change their minds," that is, to change their aims and purposes and habits of thought and inward life. We have no English equivalent, so far as I know, for the Greek words *meta-noeō* and *meta-noia;* the phrase "change of mind" expresses an idea quite too superficial. A change of the whole attitude of the soul toward life is indicated. This may, and I think does, involve looking beyond the sphere of sense; it involves a perception of something that is beyond knowledge; but this is rather psychologically involved in the mental condition than etymologically involved in the Greek word *meta-noeō*.

II. In respect to the psychological question, it is hardly necessary for me to do more than say that I am in entire agreement with you, and with what seems to me to be clearly involved if not explicitly stated in what you have quoted from Herbert Spencer. Scientific knowledge—truth that is scientifically demonstrable—is derived by logical processes from observed phenomena. This scientific process makes it reasonable to believe as a probable hypothesis that there is a psychic life which the decay of the physical organization does not destroy; but what is the nature of that life, and whether it preserves its individuality, or is absorbed into the general psychic force of the universe to reappear in new forms, are questions on which the scientific process throws little or no light. So the scientific process makes it as absolutely certain as anything can be that "we are ever in the presence of an Infinite and Eternal Energy from which all things proceed." But

far from making certain what is the nature of this Energy, ch is scientifically as unknowable as the inherent nature of ter or of force. But there is a knowledge beyond knowledge; is, a knowledge of truths which are not ascertained by logi- processes from observed phenomena, and are not, therefore, onstrable by logical processes from observed phenomena. We w all æsthetic, all ethical, all spiritual truths by other means scientific processes. Into these truths we come by looking be- d the sphere of sense; by looking beyond the larger domain of cal deduction; by æsthetic, moral, spiritual perception. We w that God is, because we commune with him as a personal nd and he is "nearer than breathing, closer than hands and "; we know that we are immortal—not shall be—because we e in ourselves a consciousness of life which physical pain and ay can not injure or impair. Thus our faith may be truth- y described as a knowledge beyond knowledge; but it is less certain and trustworthy because it transcends scientific s and demonstrations.

hope I have given a definite and tolerably clear answer to t seem to me to be the two questions implied in your cor- ondence. There is a knowledge beyond knowledge. The r of agnosticism is not in its denials; it is in its psychology; it the fact that it ignores a part and that the larger and more ortant part of man's mentality—his power to perceive directly immediately a world not cognizable, directly or indirectly, by senses; that power which alone makes him a being of taste, of ctions, of moral or spiritual capacity. The answer to agnosti- is not in maintaining that by the scientific process we can ve at certainty concerning truths which are not scientific; it is recognition of what you have called *meta-nosticism*, the pow- f grasping knowledge beyond knowledge; though the word *a-nosticism*, at least in so far as Scripture use is relied on its meaning, hardly conveys, it appears to me, though it imply, the idea which you purpose it shall convey in the ire.

Yours sincerely,

LYMAN ABBOTT.

CONCLUDING REMARKS.

Dealing with the uncorrected mistranslations of the New Ver- , Rev. Treadwell Walden says: *

t may now be imagined with what interest and expectation we looked for- l to the New Version, realizing full well the difficulty of reproducing the nal in this place and elsewhere more faithfully, and of making a change so

* An Undeveloped Chapter in the Life of Christ. The Great Meaning of the Word ola, lost in the Old Version, unrecovered in the New, pp. 14, 17, 18, 38, 39.

startling, but hoping that, *at the least*, a marginal rendering would indicate the literal alternative, or a glossarial note define the Greek expression in a way that would go far to correct the English one. But the revision flows on, making a ripple of change in almost every verse, yet with not a sign of perturbation over this sunken rock. Neither a light-ship nor a buoy warns of a spot where there has been shipwreck before now.

We understand, however, that it was the subject of discussion among the revisers, and that the matter was finally passed by, not because the present rendering was satisfactory, but because no *one* equivalent English word could be found comprehensive enough for the purpose. What, then, has been so long lost in the Old Version, remains unrecovered in the New, because of a reluctance to employ a paraphrase! The poverty of our language, in this respect, is to keep *us* poor. Or, it may be, something else was at the bottom of it, symptoms of which are apparent in other instances. It may have been the reluctance of that kind of conservatism which prefers not to disturb traditional notions or long-established formularies. We comfort ourselves, however, with the thought that the New Version is not a finality, but only tentative to that which shall yet meet the brave demand of the nineteenth century. What we have is a bold and noble move, but the whole of English Christendom are in council over it now, and suggestions and criticisms will flow in for some years to come; changes of view will also take place, making the way clearer and easier to a more fearless and absolute transfer of the original into our native tongue.

It were a bold word from any but a Divine mouth—we should say—and yet the human tongue has been uttering it, virtually, all along in another sphere. What has been the proclamation of science in its own material world, but "Metanoeite? Change your mind from the near testimony of Sense to the distant witness of Discovery"? Sense says: The sun rises in the east and revolves about the earth; the earth is the center of the celestial sphere. But Science—knowledge—proclaims a contradiction, and, with it, a revolution. It is the earth that goes round the sun, the sun is but one of that starry host, the blue firmament melts into illimitable space; it is an illuminated universe which lies out there, in which this apparently ponderous globe floats like an atom in a sunbeam. So Science, an echo of the divine voice, has enlarged, reversed the whole consciousness of man. Her metanoia has been proclaimed, not only here, but everywhere in her material field. Whithersoever she has gone, Nature has inverted its apparent order, its phenomena have widened out into once occult principles, and the first human impression of them has had to be revoked.

We can now imagine how, under such a conception, the pulpit would awake to the grandeur of its work, how the Church would awake to the grandeur of her cause. The themes of the one, the methods of the other, would move with splendor and with power to one definite and mighty end—the summoning of mankind to the metanoia, this new mind, and the announcement of *everything* on the divine side of life, which would inspire and create it. For we are just on the verge of a great epoch. All this intellectual activity in the material world is surely working toward a moment of reaction when the same intensity of movement will turn the other way, and the universal demand will be for a knowledge of the spiritual. The voice of Science, crying in its wilderness, will be found to have been preparing the way to this. It will turn out to be the "expectation" of this age. Out of its dust and ashes shall mount again the cry: "Metanoeite! for the kingdom of heaven is at hand!" Let us see to it that neither the Bible, the Church, nor the pulpit, gives *then* an uncertain sound.

Mr. Walden also quotes De Quincey as saying:

In my opinion the Greek word metanoia concealed a most profound meaning—caning of prodigious compass—which bore no allusion to any ideas whatever pentance. The *meta* carried with it an emphatic expression of its original —the idea of transfer, of translation—or, if we prefer a Grecian to a Roman areling, the idea of a *metamorphosis.* And this idea, to what is it applied? n what object is the idea of spiritual transfiguration made to bear? Simply the *noetic* or intellectual faculty—the faculty of shaping and conceiving gs under their true relations. The holy herald of Christ, and Christ himself, finisher of prophecy, made proclamation alike of the same mysterious sum-s, as a baptism or rite of initiation, namely, Μετανοεῖτε—henceforth transfig-your theory of moral truth; the old theory is laid aside as infinitely insuffi-t; a new and spiritual revelation is established. Metanoeite! Contemplate al truth as radiating from a new center; apprehend it under transfigured rela-s.

No exhibition of blank power—not the arresting of the earth's motion—not calling back of the dead to life, can approach in grandeur to this miracle ch we daily behold—namely, the inconceivable mystery of having written and ptured upon the tablets of man's heart a new code of moral distinctions, all ifying—many reversing—the old ones. What would have been thought of prophet, if he should have promised to transfigure the celestial mechanics; if ad said: I will create a new pole-star, a new zodiac, and new laws of gravi-n; briefly, I will make a new earth and new heavens? And yet a thousand s more awful it was to undertake the writing of new laws upon the spiritual cience of man. Metanoeite! (was the cry from the wilderness). Wheel into w center your moral system—*geocentric* has that system been up to this hour at is, having earth and the earthly for its starting-point; henceforth make it *ocentric* (that is, with the sun, or the heavenly, for the principle of motion).

In an appendix Mr. Walden also prints an extract from a let-of Rev. Philip Schaff, D. D., in which the latter expresses rdial approval" of the "able, excellent, and truthful article the meaning of *metanoia*," and states that "conservatism pre-ted a change, and the difficulty of substituting a precise equiva-t word," doubtless referring to the proper substitute in the r version for the word "repentance."

Attention may here be called to the fact that Hamilton says, would employ the word *noetic* to express all those cognitions ich originate in the mind itself." Why not rather employ the rds *metanoetic* or *metagnostic* for that purpose? It is to be nembered also that Lewes, in the Foundations of a Creed, says t he found it necessary to invent the new word *metempirical*, "clearly designate" the "province where sense has no footing, ere experiment can exercise no control, and where calculation ls in impossible quantities," the region of the "supersensible"; l to distinguish it from the province of the empirical, the region the sensible and the extrasensible. But that word does not m to have been generally accepted, and is not adequate for our rpose.

It appears, then, from an examination of the accompanying correspondence and quotations, that in two of the most important provinces of human thought, religion and philosophy, there is no proper and accepted English word to designate the supreme principle and element of the systems; that the universally accepted word to designate the same in one of them is, and for many years has been, known to be utterly insufficient if not false, by many among the leaders, and that in the other province such a word is much to be desired.

It is no part of our purpose to discuss the appalling disclosure of an only plan of salvation offered to the world, and yet concealed from it for ages of agony through want of a word by which to make it known; nor to discuss the effects of that disclosure upon the "common people" when it shall be finally made clear to them. After the publication of this article it can no longer be said that no attempt has been made to supply the missing word, and it will be for those whose function it is to decide such matters either to slowly adopt it, to supply a better, or to allow us to drift without it. But at this moment the word here proposed as adequate, and advocated as especially fit in view of its tendency to unite and harmonize both domains of human thought, interest, and activity concerned, has not been accepted by the leading authorities of either religion or philosophy, so far as it has been submitted to them.

However, Dr. Abbott seems to admit that, etymologically, philosophically, and scripturally, the proposed word implies, if it does not convey, the desired meaning.

As to the suggested word *hupernoia*, the fact that the preposition *huper* was not used in the New Testament becomes a striking negative argument in favor of our word. Moreover, *huper* evidently relates to quantity or proportion, and means excess, while *meta* relates to space or position, and means universally—according to Webster—in composition, beyond, over, after, etc.

Much remains to be said, but enough has already been said to open the discussion of the subject, and to put the responsibilities of the situation upon the leaders of religious and philosophic thought, to whom they properly belong.

THE objects of anthropometry, according to Mr. Francis Galton, are to define the individual or the race, and to show in what way and to what extent he or it differs from the others. By taking measurements the individual is taught to know his own relative powers at any given time, and we are helped to watch over the development during the period of growth, and to give it direction if it does not proceed normally. Measurements of the head are designed to show how much and up to what age the brain continues to grow, and to aid in comparing the educated with the uneducated classes.

TIN AND ITS NATIVE LAND.

By M. BRAU DE SAINT POL LIAS.

TIN, which every one knows, but which few, except men of science and metallurgists, are acquainted with, is one of the most precious and most interesting metals. After gold and silver, it is intrinsically the most precious of those in use. It is nearly of the same color and almost as bright as silver, but has less resistance and is less valuable. When warmed by friction, it has a pronounced odor and taste. When it is bent, the derangement of the crystals of which its mass is formed causes it, without any fracture taking place, to emit a peculiar sound which metallurgists call its cry, and by means of which an expert can nearly determine its degree of purity. The places where tin is produced are few, scattered sparsely over the surface of the globe; and it disguises itself under the form of a blackish mineral which, to the profane eye, gives no sign of the treasure that is within it.

One of the richest as well as most ancient tin mining districts is in the Malay Peninsula, the Golden Chersonesus of the ancients. The name of the province, Pérak, signifies silver; but it is peculiarly the province of tin. A few years ago we visited the mines there, ascending the Larrout River in a Chinese junk to Telok-Kartang, where a warm reception awaited us from the English colonial authorities. Thence we went, in a country wagon, and afoot after it had broken down, through a country where tigers are not rare, to Thaïping, the principal town in the district. We found lodging in the house of the assistant resident on the top of the Boukit Bandéra, which appeared to our eyes at the moment a veritable castle of the fairy tales. Opening the window in the morning, we could look from our elevated position upon the country of tin, which lay in nearly its full extent before us. Large mounds of white earth and water-holes of strange form, breaking up the surface at different points around the *kampang*, marked where mines had been worked or were still in working. Chinese coolies were climbing up and down the notched tree-trunks which served as ladders to the open pits, bearing on their shoulders bamboos, at each end of which hung the baskets in which the mineral was carried. Hydraulic wheels, which were nothing but primitive wooden Archimedes' screws, or *norias* with inclined buckets, were turning with harsh creakings, lifting the water out of the bottom of the excavations. Animation prevailed over the whole plain, in which were to be seen by turns arid spots of mineral refuse, or exuberant tropical vegetation. Farther on the country grew hilly, and the view was at last shut off by a semicircle of high mountains, in which are found the true mines, in quartz

veins charged with tin, intersecting the granitic masses. The washings of these veins, mingled with alluvial sands, have been carried down by the rivers and spread by them through the floods of the ages over the bottom-lands of the country. Taking advantage of this work of Nature, man, instead of quarrying in the mountain for the vein and having to blast the incasing rock, has only to look in the flats for the mineral.

The mines were worked by the Chinese, no European operator having been as yet established in the country. It did not take long to witness the extremely simple process by which the ore is

FIG. 1.—SUNGEI LEMBING TIN-MINING DISTRICT, PENINSULA OF MALACCA.*

extracted. After clearing off the ground, the surface and subsoil are removed for one, two, or three metres, till the mineral, tin-bearing bed is exposed; this is sometimes several metres thick. The mineral is carried in baskets, as we have seen, up the cocoa-trunk ladders, to a wooden flume which is washed by a current of water. As the mine grows deeper this labor, with the rudimentary means at the disposition of the Chinese, is made extremely difficult by the inflow of water. The washing of the tin-bearing earth is done by coolies, who with a rake remove the stones and

* The illustrations in this article are views in the lands of the British "Pahang Corporation," which has been formed to work the mines in Pahang, eastern Malacca.

work up the material in such a way as to eliminate the light sands that are mixed with oxide of tin, till only twenty-five or thirty-five per cent of foreign matter is left. The mineral thus enriched is melted in little brick furnaces, with the aid of a bellows of bamboo, which is worked by a coolie as if it were a syringe. The white metal as it runs out is cast into the well-known cubic ingots with one side flaring over the edges, so as to give them a pair of ears by which they can be more easily handled. A great deal of metal is certainly wasted in this process; and a second washing of the refuse would probably be very remunerative. The Chinese and Malays call this lost metal young tin, which is returned to the earth to ripen, because it is not yet old enough to stay in their primitive machines. It is only now, after no one can tell how many centuries since tin has been known and worked in the peninsula, that a rational system of operating the mines is about to be adopted.

The use of tin dates from extreme antiquity. Homer mentions it as *kassiteros*, in the descriptions of the arms of his heroes. Herodotus speaks of the British Islands as the *kassiterides*. The Phœnicians obtained the tin which they furnished to the ancient world chiefly from those islands, but partly also from Gaul and the Iberian Peninsula. Before the Phœnicians and the Greeks, however, the Chaldeans knew this metal under the name of *kastira*. The most ancient document in which a mention of it has been found is probably a hymn to the fire, which M. Oppert has translated from the Accadian language, a tongue the knowledge of which has been recently revived from cuneiform documents. Tin was designated in them, five thousand years ago, as *anaku*. The biblical text in the Book of Numbers, in which Moses names tin in the enumeration of the metals, is therefore comparatively modern, for it is of fifteen hundred years later date than the hymn to the fire. Even more definite than these texts is an Egyptian statuette in bronze (an alloy of tin) of the age of the pyramids, or 3600 years B. C.

FIG. 2.—NATIVE CHINESE TIN-STAMPING MILL ON THE KUANTAN, MALACCA.

Let us return to our own age, and see what is the present annual production of tin. In a recent book on the Industries of the Netherlands, M. de Ramaix gives as the production of the Dutch East Indies, ten thousand tons; of Cornwall, eight thousand tons; and of Australia, seven thousand tons; in all, twenty-five thousand tons. These figures show that the English mines have fallen off since the days of the Phœnicians, when Cornwall was the principal center of production. They have been left behind by the Dutch East Indies, and will soon be overtaken by Australia, if the number, seven thousand tons, given as the present production of its mines, is not exaggerated. Saxony and Bohemia, which still figure in the cyclopædias as sources of tin, are not mentioned in M. de Ramaix's estimate. A graver omission is that of the Malaccan mines, which I have mentioned as the most ancient, and also perhaps the most productive. According to Mr. Patrick Doyle's Tin-Mining in Larut (London, 1879) the Malay states of the Malaccan Peninsula exported to Penang in 1877, in round numbers, 2,500 tons of tin, and the Siamese states of the same country, 7,000 tons, making 9,500 tons in all. From personal information, I estimate the exportation from the single Malay state of Pĕrak, in 1881, at 6,139 tons. The production of the peninsula having grown steadily since 1876, I believe I can assert that it now takes the lead among tin-producing countries, and that the world's total present annual production of this metal is not less than 45,000 tons.*

Yet this production is hardly sufficient to supply the needs of existing industry, for the price of tin before the crash in copper, by which it was also affected, had reached the high figure of $800 a ton. This is because, while the applications of the metal have varied much at different periods, it has always been applied to numerous uses. There is hardly a house so humble that has not its utensils of tin-ware. Wherever woman has advanced beyond the crystal of the fountains, of which Sumen boasts, we are sure to find, if not a looking-glass, a mirror; and there is hardly a country so savage that European glasses silvered with the amalgam of tin have not reached it. It is used in all the applications of soldering, in tin-foil for wrapping preserved foods, and in printing-types. Some of the uses which our forefathers made of it are matters of much interest.

In the middle ages tin passed from the Gauls to the Merovingian Franks, and, according to Gregory of Tours, basilicas were roofed and tombs were covered with it. It was extensively used

* [illegible]

in convents and churches, where devotional objects of every kind were made out of it—crosses, chandeliers, holy-water bowls, other vessels, organ-pipes, and pilgrim-standards. It was allowed, with gold and silver, to enter into the composition of the sacred vessels, when wood, lead, copper, and bronze were prohibited as base or insalubrious, and glass on account of its fragility.

Bishops and priests were buried with their symbols, crosses, and chalices represented in tin. This metal served well in place of silver in the illumination of ancient manuscripts, as it now takes the place of gold in the lacquers of China and Tonquin, in which the metallic luster of tin-foil has given the transparent varnish the yellow shine of gold. Some objects found in the Italian tombs have an interesting resemblance to those of Tonquin and China. Curiously, the custom of the Chinese and Anamites, of burning papers to their ancestors bearing the figures of objects which they use while living, finds its equivalent among the peoples of Europe, who placed in the tombs of their dead tin images of similar objects, such as forks, knives, tongs, tripods, and candlesticks.

Tin was likewise employed for numerous purposes, often exalted ones, in the life of the middle ages. The ceremonial cups in which the wine was formally offered to a sovereign or to a lord making a solemn entry into a city, and the goblets given as prizes to the most adroit bowmen, were usually made of it. So were cups and measures for wine and oil, porringers, and dishes of all sizes. Plates came later. This piece, which it seems to us so natural to set on the table in front of each guest, is not of older use than the twelfth century. Even at that time every plate served in common for two or three persons. Before that, our ancestors ate, as I have done myself, among the rajahs of Oceania, each one taking the morsels with his hand from the common dish.

Grand commemorative medals, seals affixed to documents, inkstands, and tokens were struck in tin. The use of this metal was still more general in Europe in the fourteenth and fifteenth centuries. The tin eating-dish came into general use, even among peasants and workingmen, and was provided for animals. Queen Isabella's cats and the Emperor Frederick's hunting-birds had them; and tin drinking-dishes were made for the royal birds and for song-birds of every kind. Barbers' emblems, to the seventeenth century, representing a bearded figure, were of tin, to distinguish them from surgeons' signs, which were of yellow metal or brass.

Relegated till then to the kitchen or the offices of the large convents or the houses of the great lords, save in perilous times when it was brought out to take the place of silver plate on the masters' tables, tin passed, in the fifteenth and sixteenth centuries, into

—Campbell's Tin Lode (Pahang Corporation), showing Ancient Workings.

the hands of real artists. It then furnished the material for those wonderful pieces of goldsmith's work that were saved by the low price of the metal from the melting-pot which works of gold and silver could not escape, and which have come down to us as precious specimens of middle-age art. The pewterers of England, Flanders, and Spain, particularly of Barcelona, then produced works of real taste. The most remarkable art-works which remain to us from that epoch were produced in France and Germany, especially in Nuremberg, whose pots and plates of tin were as famous as its dolls. Tin thus had then all the honors of the precious metals. It still shares with the precious metals the advantage of cleanliness, which is set forth by many authors, who recommend it for the preservation of medicines that would be changed by contact with any other metal.

The importance of the question of the source whence tin was derived at such a remote age was indicated by M. Daubrey, when he said, in the French Academy of Sciences, that this metal presented a double interest: "On one side, its use in the form of bronze characterized a

rand epoch in human history; and, on the other side, the appearance of the mineral, not resembling any metallic substance, nd the rarity of its deposits, supposed knowledge among the rst miners of which we have hardly any other evidences. What country, then, in which tin is produced, was sufficiently vilized more than fifty centuries ago for its people to have nowledge enough of mineralogy to recognize the metal in the ark mineral that contains its oxide; and which had such a cial organization as to make practicable the different operations nd enterprises on which its extraction depends?" M. Germain apst expressed the opinion, three years before our first visit to érak, in one of the most remarkable and interesting works that ave been published on the subject, that this country was the peninsula of Malacca.

A curious relation has been traced between the names which ne Malays of the peninsula give to tin and lead—*tima pouté* white), tin, and *tima itam* (black), lead—and the names given y Pliny—*plumbum candidum* (white lead, or tin), and *plumbum igrum* (black lead, or lead); and also between the Malay *tima* nd the English, Dutch, and Danish *tin*, the German *zinn*, and ne Swedish *tenn*. Etymologists ask if this Malayan application f tin at a time when the kassterides islands, as yet without a ame, were lying in the solitude of their dense forests, and the rimitive populations of Switzerland, who also used tin for the rnamentation of their earthen vessels, had not yet built their ake villages, did not start from Malacca, and, carried by slow nigrations, but directly, and over the heads of the Assyrians nd Greeks, reach the extremity of Europe at a much later eriod.

Thus, this peninsula of Malacca, which is now covered by irgin forests inhabited by wild orang-sakeys, dotted with wamps that have to be crossed on elephants' backs, peopled by hinoceroses and tigers, may at that time have been at the head f the world's civilization, and had its railroads, telegraphs, telehones, temples and theatres, artists and journalists, deputies and ankers, speculators and pickpockets—everything, in fact, that ppertains to the last expression of progress, but under very ifferent forms—perhaps even its Eiffel Tower in bamboo—while urope was still in the period of its orang-sakeys. Such is the ay of the world. Why should not every country have its turn? *-Translated for the Popular Science Monthly from the Revue Scitifique.*

A SATISFACTORY report has been made of the results of the first year's working f the new educational programme of the Central Provinces of India, in which ecial provision is made for technical education.

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

III.

A FEW of the many groundless beliefs concerning both the useful and the injurious powers of certain reptiles and batrachians have been already enumerated, but such fictions are by no means confined to these uncanny-looking tribes of animals. Indeed, it would seem as if such a knowledge of the real nature of the commonest animals and plants as might readily be acquired by even untrained observers had been altogether supplanted by chimerical delusions which are incredibly hard to eradicate, for, as Dasent remarks, "popular tradition is tough."

Among the ancient Egyptians, cats were highly revered, sacrifices even being offered them and temples built for them, and after death many were preserved as mummies. Travelers state that the modern Persians, too, greatly esteem the domestic cat. But from very early times, in most countries where the cat has been kept as a domestic animal, she seems to have been an object of suspicion. Cats have been the reputed familiars of witches; have at other times been supposed to incarnate witches, or even the father of witches, the devil himself. It is, then, natural enough that cats should figure rather prominently in the list of animals credited with exceptional powers for good and evil. Remnants of many ancient beliefs concerning such powers are still found—some among us, and more, it may be, in older countries. A trustworthy old woman whose early life was spent near Cork, Ireland, tells me that it is well known that in old times cats could sometimes speak, and that she herself remembers one instance in her girlhood of a cat speaking with a human voice. "It was on an oiland aff the coast of Oireland," said she, in her queer mixture of the brogue and Yankee dialect, "a bit o' land all surrounded with water. There was a woman was cardin' wool, and after she carded it she put it into her sieve,* and then her cat came along and pulled it about, and she quished him away, and whin she did that he said, 'Ye'd better lave this oiland, or ye'll be sorry.' And nixt day there came up a very high tide, and swipt away ivery livin' thing on the oiland. I suppose the cat just wanted an excuse for spakin' whin he tangled up the woman's wool. Ah, cats are very knowin'! and there's great virtue in a cat's blood, 'specially that of a black cat, or its skin, aither." Al-

* A kind of wide hoop, with the bottom covered with tanned sheepskin, and used to hold the carded wool.

most every one is familiar with the time-honored belief that a cat must not be left alone in the room with a little child for fear that "the cat will suck the baby's breath." So general is the belief in this breath-sucking power of the cat that I have taken pains to consult several distinguished physicians in New England as to its probability, and have received from each a most unequivocal statement of disbelief in any such phenomenon. One eminent Boston physician suggests that the notion may be based on the fact that a cat likes warmth, and naturally might lie up close to the warm breath of a sleeping child. Any injury which the latter might receive would therefore come from breathing an impure air, charged with carbonic-acid gas, and if the cat were diseased—for instance, had consumption—there would be the possibility of inhaling the bacilli or germs of tuberculosis. But is it not more than possible that the popular apprehension is descended from the old-country dread of the animal's connection with witchcraft? De Gubernatis cites the fact that, in Monferrato, black cats, being thought to be witches, are carefully kept away from the cradles of children; and the same precaution is taken, for the same reason, in Germany. In the latter country, black cats are in general thought to be ill-omened creatures, and, if one is found on a sick-bed, it foretells death; or if on a grave, it signifies that the soul of the departed is in the possession of the evil one. In earlier times, I conclude that black cats were usually considered to be especially evil-boding; but this notion has apparently undergone a change, so that now the white or light-colored cat is often reckoned the forerunner of evil, while the black one is the harbinger of good. There is a popular saying in various parts of New England that it betokens good luck to be followed by a black cat. A black or gray cat or kitten coming to a house will bring good luck, but a white one is a sign of calamity. "If you drive away a black cat that comes to you, you drive away your luck." The possession of a black-nosed, "smutty-nosed," cat brings wealth, while in Maine it is said the ownership of a white cat entails poverty. In Canada and parts of Michigan I find the notion is that lucky cats are those of three colors, and therefore the owner of one of the not uncommon variety, mottled with black, white, and orange, should keep her as a *mascot*, or luck-bringer. Among the negroes of Alabama it is believed that after death the spirits of old maids take possession of black cats. There is a popular belief in parts of Pennsylvania that, if by accident cats' hair be swallowed, it will turn into worms. In central Maine one may find a more generalized form of this superstition. The belief there is that, if any kind of a hair be allowed to enter the human stomach, it will gradually change into a snake—the species of the latter undefined. A native of Cumberland, England, has told me that there it is a common say-

ing that one must not swallow a hair of a cat, since if swallowed it will develop into a kitten within its hapless host.

From southern Illinois comes the notion that a felon may be cured by simply putting on, dry, three hairs from the tip of a black cat's tail. It would be so very easy a matter to test the efficacy of this remedy that it is almost incredible that experiment has not before now dissipated such an absurd belief even from the most credulous mind. Possibly there is some relation between this prescription and a saying found in central Maine that in the tip of every cat's tail are three hairs of the devil. All are aware of the ease with which in cold, dry weather, the fur of a cat is electrified by friction; but who would imagine that any connection could be conjectured between this phenomenon and lightning? There is, however, a New England superstition, of greater or less extent, that it is very unsafe to tolerate the presence of a cat during a thunder-storm. I know of one lady in Salem, Mass., who never allows her cat to remain in the living-rooms of the house when a thunder-storm is threatened. No sooner do dark clouds begin to gather than Tabby is relegated to the cellar for fear "she may draw the lightning." The reasonableness of this precaution is quite worthy of the superstition which occasions it. The grease tried out by roasting a perfectly black cat is recommended in northern Ohio as a curative ointment in any disease of the skin. From central Maine came the preposterous notion that consumption may be cured by cooking a black dog (one without a white hair) and eating the fat on bread. In the same region a much-prized unguent for pimples, roughened skin, or any other cutaneous disturbance, is the grease of a weasel. It would certainly seem that but a trifling quantity of fat could be obtained from one of these slender creatures. Pliny states that the gall of one kind of weasel (probably the ferret) is a most efficacious remedy for the sting of an asp; also that the flesh of another species, preserved in salt, is a cure for the bites of serpents. The dried flesh of the weasel was often kept by the ancient Romans to be given in small quantities as an antidote for any narcotic poison. Indeed, great remedial powers were, according to Pliny, attributed by his contemporaries to these animals, their ashes being often kept to form an important ingredient in some of the grewsome compounds that figured so largely in Roman therapeutics. Most Aryan mythologies abound in tales of the supernatural wisdom and cunning of the weasel. Phædrus and Æsop both introduced it into their fables; and Aristotle, in his History of Animals, among other attributes ascribes to it enough reasoning foresight to eat the herb rue before attacking serpents. The Greeks supposed the odor of this plant to be obnoxious to these reptiles, and credited their wily adversary with a

knowledge of the fact. Wherever found, the weasel has, and I suppose deservedly, a general reputation for great cunning and alertness. But of all the various beliefs in its fabulous powers and attributes so prevalent among earlier civilizations, few, so far as I have been able to ascertain, seem to have descended to our own time and country, though a good many still hold their ground in various parts of the British Isles. In the north of England it is popularly thought to be very unsafe to molest a weasel or to kill or injure its young, lest the artful animal spit on the offender and paralyze him, or else secretly spit into his food and so poison him. A young emigrant from county Sligo, Ireland, has told me that the peasants there have undoubting faith in this capacity of the weasel to avenge itself by the voluntary ejection of saliva that is poisonous to man. I wish I might reproduce the rich brogue and open-eyed credulity with which this Irish boy related several stories illustrative both of the revengeful disposition and of the reasoning ability of the weasel. But I can only give, in an approximation to his language, two instances which he assured me had come under his own observation. "A mon in our part o' the country wonst fought wi' a weasel. She was vurry mad un' she fought 'um a long time, un' at las' she spet on 'uz shins. The mon was afeard then un' let her alone, un' I meself saah wheriver the weasel 'd spet on 'um, uz shins turned black in spots." "There was a lot o' min a-wurrkin' in a field, un' wan uv 'm tuk some little young weasels out av their nist in a wall that was theer. Thin whin th' ould weasel saah what was done wi' 'um, she just wint to the can o' milk that they had for their dinner, and spet in th' can un' wint aff; un' thin the mon wint back wi' the little weasels afther he'd watched th' ould one a bit, un' he lift thim in the nist. Un' thin th' ould weasel wint as quick as iver she cud to the can o' milk un' spilt it so the min cudn't dhrink any uv it. She wudn't be afther hurtin' 'um whin they'd taken the little wans back." The country people in county Sligo believe that these agile carnivores are so very cunning that they know all that men say about them, and so it is felt to be unsafe even to speak ill of the little thieves. It is also there thought to be very lucky to carry a purse made of a weasel's skin. There is an old custom among the Irishwomen in county Kerry to go out with bread or other food in their hands, to meet hunters coming home with their ferrets, and after feeding the latter, to keep "for luck" whatever crumbs are left over.

An old-time remedy for the disease commonly known as "the shingles" (herpes zoster) still survives in the United States, ranging from Maine through Massachusetts and New York to Ohio, and perhaps even more widely. The treatment consists in the application of the skin of a freshly killed cat to the diseased surface

of the body. In Massachusetts it is believed that to be efficacious the skin must be that of a black cat. In one country town in eastern Massachusetts the same remedy is recommended for hives. A reputed cure for asthma, still extant in Boston, is to wear a muskrat-skin, the hair to come next the chest of the patient. A correspondent from central New York *knows* of inflammation of the bowels having been cured by applying the flesh side of the pelt of a freshly killed lamb. In parts of Ohio it is thought that chilblains may be quickly relieved by wrapping the feet in a "warm, bloody rabbit-skin" (hare-skin). The last-named remedy calls to mind the method of curing ruddiness of the face by anointing it overnight with hare's blood, cited in that incomparable medley of wisdom and folly, Burton's Anatomy of Melancholy. The nausea attendant on the painful disease called milk-sickness, which is so dreaded in many of the newly settled parts of the Western States, may, it is said, be allayed by drinking hot water into which has been dropped a little freshly drawn blood of a chicken. Canadian lumbermen, when fortunate enough to shoot a deer, often wrap themselves at night in its skin in order to keep off witches.

Pliny, in his Natural History, states that the bite of a serpent may be cured by immediately applying to the wound a living mouse, split asunder, or the warm flesh stripped from the bones of a cock. We find a possible survival of these ancient Roman remedies in the application of the freshly cut surface of a stunned domestic fowl to a snake-bite. The poison is supposed to be absorbed by the quickly circulating blood of the chicken and finally to kill it. If it die before most of the poison is thought to have been absorbed, another is at once to be applied. This mode of treatment is reported from Michigan, but I have reason to believe that in a more or less modified form it prevails rather generally where poisonous snakes are found. In northern Ohio they say that a living fowl cut open and applied while bleeding constitutes another cure for "shingles." In the town of Woburn, Mass., it is not snake-poisoning or shingles, but scarlet fever and diphtheria, that may be cured by applying to the chest the palpitating body of a hen that has been stunned and immediately cut open. This last remedy recalls the account of the last illness of Philip of Burgundy (Philip the Good), in Charles Reade's admirable mosaic of mediæval life, The Cloister and the Hearth. You remember that in the latter part of the fifteenth century the duke lay sick at Bruges with the disease now known as diphtheria. "Ho! this is grave. Flay me an ape incontinent and clap him to the duke's breast," says the doctor. But no ape was to be had. "Then Doctor Remedy grew impatient and bade flay a dog. 'A dog is next best to an ape, only it must be a dog all of one color.' So they

flayed a liver-colored dog and clapped it yet palpitating to their sovereign's breast; and he died."

There is a popular supposition of wide range, based upon I know not what, that it is very healthful for children to play with dogs. A weak child, it is thought, may gain strength by being with a dog, or, if diseased, the child may be cured by having the animal "take the disease"—for example, inflamed eyes or any disorder of the skin. Within a year a college graduate told me, in perfect good faith, of acquaintances, a Boston doctor and his wife, whose little girl had been greatly afflicted with some form of eczema which they all hoped would disappear, as the parents had purchased a fine dog to play with the child.

When a dog is teething, the upper incisors, according to a New England superstition, must be removed as soon as they become loose, or he may "swallow them and have fits." Perhaps even more generally received is the fancied danger of allowing a child's milk-tooth after extraction to fall into the possession of a dog or cat, lest the animal swallow it, and the child have a dog's or cat's tooth grow in place of the lost one. The Mexicans and Indians in Texas say that every animal has brains enough to tan its own skin; and so the latter, in the case of the wolf, panther, wild cat, and some other animals, is mainly prepared by rubbing into the flesh side of it the brains of its former wearer. A somewhat common fancy among children, perhaps too among adults as well, is that "every part strengthens a part"—that is, that the liver, heart, brains, and so on of animals, when eaten, go directly toward nourishing the corresponding organs in the eater. A similar doctrine was worked out in great detail by the American Indians, and is, I believe, held by many other savage tribes. It seems altogether probable that such beliefs, wherever found among civilized people, old or young, are survivals from remote antiquity, and that they are closely akin in their nature and origin to the well-known doctrine of signatures which has played so great a part in the systems of medicine of primitive peoples.

Mr. Charles Aldrich, of Webster City, Iowa, relates the following curious superstition: "A neighbor residing on a small farm near me has, on several occasions, spoken of his experience with 'hog mice.' He came to this country many years ago from Northamptonshire, England, where he had often seen these strange animals. They are also occasionally seen by him here in Iowa. This mythical rodent is about the size of a barn mouse, but its striking peculiarity as to its outward appearance is, that it has a head and face fashioned exactly like that of a hog. It is a very 'uncanny' little beast. If it merely runs across the body of a sleeping person, or of a domestic animal, such unfortunate person or animal will be grievously afflicted

with lameness or soreness wherever the mouse sets down one of its little feet. Serious disability often comes from the touch of the ''og mouse.' In some extreme cases the affliction is well-nigh incurable, and may last a lifetime. My old friend said that it was no hearsay matter with him. He had 'seen 'og mice both in Northamptonshire and 'ere in Hamerica.' One of his colts 'was disabled by a 'og mouse running hover it, and was a long, long time getting well.' A striking peculiarity of the hog-faced mouse, according to my old friend, is, that it is never seen at rest, but always 'on a dead run,' as if fleeing from pursuit."

It seems to me almost certain that this redoubtable ''og mouse' is merely a shrew, whose long and pointed snout might suggest the visage of a hog. In Great Britain the most maleficent powers are commonly attributed to shrews, and an interesting passage concerning the matter in White's Natural History and Antiquities of Selborne deserves to be quoted *verbatim*: "At the south corner of the plestor, or area, near the church, there stood, about twenty years ago, a very old, grotesque, hollow pollard ash, which for ages had been looked on with no small veneration as a shrew ash whose twigs or branches, when gently applied to the limbs of cattle, will immediately relieve the pains which a beast suffers from the running of a shrew mouse over the part affected; for it is supposed that a shrew mouse is of so baleful and deleterious a nature that, wherever it creeps over a beast, be it horse, cow, or sheep, the suffering animal is afflicted with cruel anguish, and threatened with the loss of the use of the limb. Against this accident, to which they were continually liable, our provident forefathers always kept a shrew ash at hand, which, when once medicated, would maintain its virtue forever. A shrew ash was made thus: into the body of the tree a deep hole was bored with an auger, and a poor devoted shrew mouse was thrust in alive, and plugged in, no doubt with several quaint incantations long since forgotten. As the ceremonies necessary for such a consecration are no longer understood, all succession is at an end, and no such tree is known to subsist in the manor or hundred."

It appears that similar powers for evil have also been attributed, in parts at least of Great Britain, to field mice, which by creeping over the backs of sheep were thought to produce paralysis. The remedy for such an injury was to inclose the mouse in a tree, and stroke the afflicted animal with its branches as above described. How far, if at all, these old-country superstitions have become naturalized among us I do not know.

The belief that the American porcupine (*Erethizon dorsatus*) can at will "shoot" its quills is one of wide acceptance among unscientific people. I remember the woodcut in my first spelling-book, labeled *porcupine*, and how, in reply to my questions in

regard, to the nature of the bristly-looking little fellow, I was told of his protective power of discharging a volley of quills at either a hunter or any four-footed enemy. This interesting fable about our own unaggressive rodent is doubtless an application of a similar exaggeration of earlier origin concerning the African porcupine. No doubt the story arose at the outset from the extreme readiness with which the quills are detached from the skin of their owner, contrasting remarkably as it does with the savage hold which their minute barbs take of the flesh of the incautious meddler in whom they lodge.

A cure for a felon, recommended in central Maine, is to wrap the offending finger in the thin membrane which lines an egg-shell. More interesting than this is the south of Ireland conceit that sucking the first egg laid by a black hen will clear the voice and render it musical.

One of the most unique of veterinary remedies is the following sent me from Bradford, Mass.: "If a cow lose her cud, put a live frog down her throat and it will bring back the cud."

In Alabama and Texas a hymenopterous insect, of the family *Mutillidæ*, which bears a superficial resemblance to a red ant, is locally known by the entirely undeserved name of cow-killer, from the supposed destructive effect of its sting upon cattle.

The dragon-fly is greatly feared by little folks in Maine, as they believe that it often sews together the lips of children, and if the mouth be left open to prevent the sewing of the lips the warning cry, is "Look out, he'll sew up your swallow!" A very cautious little girl, therefore, was accustomed on sight of one of these insects to open wide her mouth, keep her lips far apart, and then cram her fist into her mouth to keep the enemy out of her throat. In parts of Massachusetts the story goes that it is only children who tell lies who are in danger of having their mouths sewed up by the "devil's darning needle," while in New Hampshire and parts of Pennsylvania, the children think that their ears, eyelids, nostrils, and lips must be guarded, or they may be sewed up by the dreaded darning-needle. This graceful and beautifully colored insect has various names besides the well-known one just mentioned. In New Jersey it is often called "spindle"; in the neighborhood of New Orleans, "mosquito-hawk," and very likely this may be a most rational appellation; but it goes without saying that that of "snake-doctor," common in many of the Southern States, is entirely senseless. The negroes and ignorant whites, however, really believe that ailing snakes are attended by these flying "doctors." In Tennessee and Illinois either "snake-doctor" or "snake-feeder" is the popular name, and the latter is the one in general use both among children and adults in Ohio, Indiana, and some other States of the Mississippi basin. When a child in northern

central Ohio, I remember that neither my playmates nor myself doubted, when we saw dragon-flies darting to and fro or hovering over ponds or swamp-lands, that they were carrying food to their friends the snakes; and the sight of a snake-feeder always put those who feared snakes on their guard.

Some years ago a friend of mine was spending the night in Boston. Her hostess advised her, upon retiring, to be sure and keep the bedclothes well over her feet during the night, as the house was infested with cockroaches, and it was said that the insects would gnaw one's toe-nails if opportunity offered. This suggests a rather popular New England superstition that if you kill a cricket the rest of the tribe will come unawares and bite holes in your clothes. We find the same superstition in Ireland. The Irish in general say that it is very lucky to have crickets come to take up their abode in your premises, only you must be very careful not to injure one. A young Irishman once told me that if by chance boiling water were spilled upon one, as might easily happen among the peasants who cook by an open fire, about the hearth of which the crickets like to live, the unlucky person who had done the injury would be sure to find that the crickets had gnawed holes in his socks and other garments during his sleep; at the same time and in the same room the clothes of other persons who had not harmed the crickets would be unmolested. A Maine saying is that, if one of the sprightly elves become imprisoned in some crevice, ill-fortune will surely attend any bystander who does not release him. In some places with us the cricket is said to be propitious, but there is a Maine belief that its chirping foretells sorrow. This is a probable outgrowth of the saddening effect of long-continued listening to the little reveler's music, so mingled in its cheer and pathos. We may pretty certainly conclude that our whimsies about the cricket have in the main been directly transplanted from the British Isles, while those of the latter region are, in turn, modified versions of ancient ancestral beliefs common to many branches of the Aryan race. In White's Selborne the author says, in speaking of crickets: "They are the housewife's barometer, foretelling her when it will rain; and are prognostic sometimes, she thinks, of ill or good luck, of the death of a near relation, or of the approach of an absent lover." Among various prognostications of death recounted in the poet Gray's Pastoral Dirge we find—

"And shrilling crickets in the chimney cried."

The Spectator says that the voice of the cricket has inspired more terror than the roaring of a lion. According to Pliny, the cricket was an insect greatly esteemed by ancient magicians.

It is often said that the house-fly is indigestible by the human

stomach. If one is so unfortunate as to swallow a fly, the comforting remark very apt to be offered among country people is: "Well, it'll come up; a fly won't stay on the stomach, you know."

In central Illinois pills made by rolling up spider-webs into small balls are recommended to be taken for ague. In connection with this remedy it may be interesting to notice that Burton, in his Anatomy of Melancholy, tells how his mother, who was much given to doctoring the poor of her parish, had great confidence in the efficacy, in ague cases, of a spider inclosed in a nutshell wrapped in silk, to be worn as an amulet by the patient. Burton himself was at first incredulous, but after some observation he came to believe that the amulet was beneficial. His own conclusion was greatly strengthened upon his finding authority for this use of the spider in the writings of Dioscorides, the famous botanist, who lived in the early part of the Christian era, and whose Materia Medica, written in Greek, was for fifteen hundred years the highest medical authority. Carrying spiders upon the person as an ague-cure must once have been somewhat popular in England. Brand quotes from the diary of Elias Ashmole, April 11, 1681, the following: "I took early in the morning a good dose of elixir and hung three spiders about my neck, and they drove the ague away. Deo gratias!" Indeed, a vastly greater antiquity may be assigned to this absurd practice, for the use of a spider's web or the creature itself as a specific for ague can at least be traced back to the first century of our era; for Pliny, in prescribing for this disease, says: "It may be worth while to make trial whether the web of the spider called 'lycos' is of any use applied with the insect itself to the temples and forehead in a compress covered with resin and wax; or the insect itself, attached to the body in a reed—a form in which it is said to be highly beneficial for other fevers." In the medical chapters of his Natural History Pliny again and again speaks of the remedial virtues of spiders and their webs, and, among multifarious prescriptions of this kind, advises the application of a spider for three days as a cure for a boil, care being taken not to mention the animal's name before applying it; also of cobwebs wet with oil and vinegar for fracture of the skull, or of the web of a white spider for chapped lips. I have chanced upon several other spider-web remedies in our own country besides the ague-cure above mentioned. A Deerfield (Mass.) mode of treatment for felons is merely to wind the finger about with cobwebs. In northern New York cobwebs wet in hot water and applied externally are recommended for the relief of pain in diseases of the kidneys and bladder. The same application is used in parts of Vermont for acute inflammation of the breast.

A quaint custom is widely prevalent among country boys and

girls of asking a "daddy-long-legs" to point out the direction in which pasturing cattle may be found. When I was a little girl in northern Ohio, many a time, before starting to drive home the cows from a woods-pasture—in which they might easily have wandered out of sight—have I looked about in the angle of a gate-post, or under the cap of a board fence, in whose shady corners the daddy-long-legs often lurk, and, having found one of the torpid beings, seized him by one leg and held him as I repeated our prescribed incantation:

"Gran'-daddy, gran'-daddy-long-legs,
Tell me where my cows are, or I'll kill you!"

Naturally, the spider, discomfited by his bondage, would lift one of his legs, and the cows, it was said, would be found in the direction indicated by this uplifted leg. I don't think that we children really believed that this indication would always hold good, or that we even paid very much attention to the path so designated; but, as I remember it, we felt it to be the proper thing to do to consult our oracle, and I doubt not the ceremony sent us off on our evening quest with better courage. The same custom is reported from different parts of New York State, Indiana, Illinois, and Tennessee. The incantation varies somewhat with the locality. In Tennessee it is simply—

"Daddy-long-legs, which way are my cows?"

An old physician writes me that "in western New York, sixty years ago, the verses ran—

'Grandfather gray-beard,
Tell me where my cows are, or I'll kill you!'

After this had been repeated several times in a drawling monotone, lengthening out the syllables 'gray' and 'kill,' if the captive lifted a leg and held it suspended for a moment, he was faithfully released; otherwise, he was ruthlessly killed." Certainly there must be some occult connection between these malodorous arachnids and the cows, for in Tennessee the farmer-boys tell you that killing a grand-daddy-long-legs will make the cows go dry.

In the pine woodlands of southern Louisiana, so a New Orleans lady writes, there are found little mounds of mud, with quite a large opening in the center of each—probably crayfish-holes. Negro nurses caution the children under their charge never to touch these tiny mounds, believing that they are snake-holes, and that any meddling will lead the snake which lives there to leave his burrow at night and come and bite the offender.

In western New York, forty or fifty years ago, the panacea for dirt or other foreign substances in the eye was what the children called "crabs' eye-stones," the two calcareous, lenticular concretions found between the stomach-walls of the crayfish. In these

gastroliths is stored away for the molting season a reservoir of material to form a new shell. The children, having no knowledge of the real use of the gastroliths, believe them to be a providential arrangement for the relief of pain in man, and for generations this belief has been entertained by adults, for the gastroliths are really the commercial eye-stones that were once widely used to remove any irritating particle from the eye; but the practice is now condemned by physicians. It is scarcely possible that there is any power *sui generis* in these neat little bodies which an artificial fac-simile would not possess. Very likely this widely credited virtue of the eye-stones is a result of the varied use in medicine of the European crayfish in past ages. Powdered gastroliths were formerly used in Europe as an antacid, while Pliny cites a score of prescriptions in which the crushed animal, the bruised flesh, the juice expressed from it, macerations in various liquids, or the incinerated and pulverized shell were recommended for all sorts of purposes from antidoting poisons to allaying fevers.

Some time ago I heard a very notable New England housekeeper ask a young girl, who was assisting her by preparing a lobster for the tea-table, if she had been careful to remove the "lady." In answer to my inquiry as to what was meant by this, I was told that there is a part known as the "lady"—a small, greenish object inside the lobster, which is a perfect image of a tiny woman seated in a chair—and that this part of the animal is deadly poison, and should therefore always be carefully removed in preparing the flesh for the table. I find that, in general throughout Massachusetts, this name of "lady" is given to the stomach, which may be imagined to bear a remote resemblance to a miniature woman. Since the lobster is a notorious sea-scavenger, the contents of the stomach would probably be very undesirable for food, though why this stigma of being poisonous should need to be attached to the hard, calcareous-toothed, inedible stomach-walls it would not be easy to tell. In central New Hampshire the name "lady" is sometimes applied to the intestine—the dark tube running lengthwise of the lobster's body—and this is considered poisonous. In Cambridge, Mass., an intelligent fish-dealer, on being questioned as to the nature and position of the "lady" in the lobster, designated by that name the edible ovary popularly called the "coral." An ingenious theory has been propounded to me to explain the cause of the so-called "lady" being dangerously poisonous. The reasoning was about as follows: "You know that lobsters must be alive when they are dropped into hot water to be cooked. If you should let them die before they are cooked, they would be poison and not fit to eat, and I suppose that the poison, which before they are cooked is scattered everywhere through its whole body, all goes into the "lady" while the lobster is being boiled."

In Louisville, Ky., the children are afraid to kill the common sow-bug (*Oniscus*), which they call "mad dog," believing that the disagreeable-looking little crustacean can give one the hydrophobia. In my own mind there is a faint recollection of having heard that a poultice made from these creatures possessed great remedial powers of some kind. The genuineness of my half-obliterated reminiscence of the therapeutical value of the sow-bug lately received an unexpected confirmation from the pages of a copy of The Complete English Dispensatory, by John Quincy, printed not far from the middle of the eighteenth century. This rare old book, which had long lain among the unconsidered rubbish in the garret of an old-fashioned New Hampshire farm-house, contains a vast amount of curious medical lore. Not a few of the remedies which it describes are so alchemistically compounded as to seem to have come straight down from the later adepts in that pseudo-science. Other preparations, again, are unpleasant enough in their composition to satisfy an ancient Roman or a modern Chinese practitioner, as witness the following (by no means one of the most objectionable):

"EXPRESSIO MILLIPEDUM SIMPLEX (*A Simple Expression of Millipedes*).—Take live millipedes and white sugar ana ℥ iij, beat them well together in a marble mortar, and pour upon them lb. j of white wine, which strain out again by hard squeezing."

This formula is quoted by Quincy from Dr. Fuller's Pharmacopœia Extemporanea as a diuretic. Among other synonyms for "millipedes" as here used, Quincy gives "sows" and "onisci." I find that Pliny recommends "millipedes" (which the editor of the translation of the Natural History in Bohn's series identifies with onisci) for pains in the ear. Holland is quoted in a foot-note in the above-mentioned translation, as sanctioning the use of woodlice (sow-bugs) for pains in the ears; and the editor also states that English school-boys swallow them alive, and that old women advise their use in consumptive cases.

Perhaps every one has noticed the club-shaped, whitish mass at the proximal end of a freshly pulled human hair. This root of the hair, together with the attached connective tissue and adipose material, is often absent, from the fact that the hair frequently breaks off near the opening of the follicle, instead of coming out entire from the interior of the latter. So it has come about that the root of the hair is in different localities mistaken for an animal parasite, called a *hair-eater*. In many places in Maine and Massachusetts, if these bulbs are noticed among combings, people will say that the scalp is infested with hair-eaters, and that the latter must be killed, or they will certainly ruin the hair.

NATURAL AND ARTIFICIAL CEMENTS.

By Prof. LA ROY F. GRIFFIN.

THE cements now in the market are of two kinds: natural, made directly from stone; and artificial, commonly called Portland cement. The manufacture of the former consists simply in burning and grinding the cement stone, a magnesian limestone containing about fifteen per cent of silica and a little silicate of alumina. The burning drives off the small amount of combined water and all the carbon dioxide from the stone, leaving the lime and magnesia as oxides, while the grinding to a powder puts it into the best possible condition for mixing with sand and gravel, and moistening to form a mortar. Artificial cement consists of about sixty-two per cent of lime mixed with silica and silicate of alumina in nearly the same proportions as those found in the cement stone, and it is free from magnesia. This seems to be the whole difference in its constitution. In use, the artificial cement sets rapidly and attains maximum hardness in a comparatively short time; the natural cement hardens rather slowly and reaches its maximum hardness only after a long period of exposure to the air.

The increasing use of cement in modern construction, either alone or more commonly as mixed with sand and gravel, demands that the qualities of the different kinds, and the means of testing, both roughly and accurately, should be generally understood. The foundations of all important structures, in situations where they can not rest directly upon solid rock, owe their strength to cement. They are usually made of concrete, cement mixed with sand or gravel, and they are often strengthened by iron beams so as to bind the whole into one continuous mass. Tunnels under rivers, sewers, cable trenches, and all the numerous subways of our large cities, are either concrete or masonry laid in cement mortar. Their strength, again, is the strength of the cement used. And even the piers of most of the large bridges are now made in part or wholly of concrete. Oftentimes, even the walls of stone and brick buildings are rendered more secure by being laid up with mortar of which cement forms a large ingredient. Used for so many purposes, the necessity of uniform quality, and proper knowledge of the quality of the cement used, become plain.

Before examining the methods of testing now employed and comparing the results, the process of hardening needs to be comprehended. Some things are not yet quite clear in it, but it is certainly in the main a chemical process. Mixed with water, the lime and magnesia of the cement unite to form a hydrate, and it

is probable that the silicates also recombine with some of the water. This is the first step, and produces the so-called setting. It is best passed through while the cement is exposed to the air, and is the reason why cement mixtures must be used as soon as moistened. But, this now complete, a more complex process is set up. The moistened cement brought in contact with the air, or exposed to water, at once begins to absorb carbon dioxide, for all ordinary air contains the gas, and most water holds it in solution. The gas unites with the lime to form a carbonate again, and this goes on until the whole of the lime is turned back to limestone. The same change occurs in the magnesia, but in this the action proceeds more slowly. With a pure lime cement this action is probably nearly complete at the end of a few months; but, with a cement containing magnesia, it will continue for many years. The strength of the cement increases so long as the change continues. So a Portland cement will develop its full strength in a few months, while our natural cements will not for years, and, so long as it continues, the structure improves.

Rough testing of cement, so as to enable a workman to get a crude and imperfect idea of its value, is easy. Enough of the pure cement should be taken to make a ball an inch in diameter and mixed with just sufficient water to make it mold readily and be rolled into a ball. Then it should be exposed to the air and left for two hours. At the end of that time it should be set; then it should be put into water and left. It should grow gradually harder, and should show no signs of cracking or crumbling, even when left for ten days. Any cement that does not endure this test is not of sufficiently good quality to make satisfactory structures; any cement that stands this properly will be generally satisfactory if properly used.

In determining how to construct a building, a series of tests is often required that shall show tensile, breaking, twisting, and crushing strength, and also adhesion of the materials used for mortar. No one of these can be dispensed with, since material that will endure one satisfactorily will often fail utterly in another, and hence prove worthless for the use desired; but for general purposes the test of cement which is the most valuable is that which determines its tensile strength. Comparative tests of this show the value of cements from different sources better than any other one test.

To make an accurate test of any lot of cement, great care is necessary in selecting and manipulating the samples. The test sample ought not to be taken from a single package, but from several in equal quantities and thoroughly mixed. The sample must also be carefully protected from air and moisture until the test is made. When used, it must be molded with just the right

amount of water to render it plastic. Too small an amount will leave some particles dry; too large an amount will gather in masses, will evaporate, leaving pores, and will give too small results. The test is now commonly made by molding a *briquette* of a form approved by engineers, as shown in Fig. 1, which is drawn of one third actual size. The mold is a clamp of metal exactly one inch in thickness and exactly one inch across at R. This makes the area of the smallest place exactly an inch. The moistened cement is carefully placed in the mold with a spatula and pressed enough to render the whole mass homogeneous. It is left in the mold until it can be removed by opening the mold, and then it is exposed to the air for exactly twenty-four hours, after which it is put into water and allowed to rest there until the test is made. The length of time depends upon the purpose of the test. In order to make certain that all the cement produced is of a uniform quality, seven days is sufficient. Such a test is made of every lot shipped by the Milwaukee Cement Company, and probably by all other reliable manufacturers. If the test is to determine the ultimate strength developed or to compare cements from different sources, then a series of tests should be made by breaking "briquettes" made at the same time but left in water for different periods. The reason is, that a quick-setting cement will develop its full strength in a short time, and if the test is made at the end of that time it might show a greater tensile strength than another one slow in setting, even when the latter would ultimately have several times its strength.

Fig. 1.

Fig. 2.

The test can be made in any form of testing machine, though one in which the test is applied by uniformly increasing the strain, as by running shot into a bucket upon the end of a lever, gives the most accurate results; but the briquette should be held in a clutch that presses accurately upon the sides, as shown in Fig. 2. This applies the tension equally, and gives a very accurate test. A long series of these were made by Mr. D. J. Whettemore, C. E., at Milwaukee in 1874, in which seventeen native cements showed an average tensile strength at the end of seven days of 80 $\frac{8}{10}$ pounds. The lowest of these broke at 38 pounds, while the highest sustained 139 $\frac{3}{4}$ pounds. Later tests made in

the same way have shown that these were unreliable as final tests of strength, because the briquettes had not hardened sufficiently, and the table would place inferior cements above those of much greater strength because the inferior develops its ultimate strength much sooner. But a comparative test of the same cements when mixed with sand in equal parts was also made, and is of very great value and probably perfectly reliable, for the tests were then made at the end of ninety days, so giving the slow-setting cements time to develop their strength.

Thus the one which in the test applied to clear cement broke at 38 pounds now sustained 152¼ pounds, an increase of four hundred per cent; while the one that was the strongest at the end of seven days now broke at 204½ pounds, an increase of only fifty-four per cent. The one that showed the greatest tensile strength of all, at the end of ninety days, the Milwaukee cement, 290 pounds, broke at only 96 at the end of seven days. An experiment made with a briquette taken at random, that had been made six months and exposed to the air at least half that time, strikingly showed the same fact, for it broke only under a strain of 636 pounds. This test was made simply to show the writer the method of using the testing machine.

The United States Government had a series of tests made a few years ago, using the cements commonly sold in the West, and giving in each case the mean result of seventy-five tests. The table is so interesting that we give it entire.

Tensile Strength of Pure Cements, each Test given being the Mean Result from Seventy-five Specimens, Thirty and Sixty Days.

	Thirty days.	Sixty days.
	Pounds.	Pounds.
A Cement	320	345
B Cement	288	310
C Cement	303	330
E Cement	220	280
F Cement	202	282
D (Milwaukee)	382	350

Cement is far more often called upon to resist a crushing than a tensile strain. A large number of tests has been made to determine the weight required to crush a cube one inch in each dimension. When mixed with sand in equal proportions, the best cements will sustain a crushing weight of upward of a ton, the specimen having been allowed to harden for ninety days, while the poorest do not sustain quite half a ton, and even when mixed with three parts sand to one of the cement, the Milwaukee, which tests have shown the best, sustains over eleven hundred pounds. These tests show conclusively that structures well built of mixed cement

and sand or coarse gravel will sustain any reasonable weight without danger of yielding.

Little needs to be added upon adhesion. Many attempts have been made to determine the adhesive strength of various cements, usually without success—not because they do not hold properly, but because they hold until the brick or stone to which they have been applied is ruptured before the cement is separated from its surface. This shows that the adhesion is always sufficient for all uses, and this seems to be true of all our native cements. Their use, therefore, mixed with mortar adds greatly to the strength of the structure.

All these qualities of cement warrant its continual and increased use, particularly of all the better grades. Probably the English Portland is the best of all, but its cost is so much beyond that of our native cements as to warrant using them in its place in somewhat larger proportion in all places where time can be allowed for the hardening.

SKETCH OF THEODOR SCHWANN.

By M. LÉON FRÉDÉRICQ.

ON the 23d of January, 1878, was celebrated at the University of Liége, by the scientific men of Belgium and others representing neighboring European states and more distant countries, the fortieth anniversary of the professorship of Theodor Schwann. Men of all nations joined, by their presence or by letter, in honoring the man who, as the founder of the cell theory, had showed that all the varied and complex manifestations of Nature are one in kind, and had given a new direction to physiological research.

The object of this demonstration, THEODOR SCHWANN, was born on the 7th of December, 1810, at Neuss, near Düsseldorff, in Rhenish Prussia, and died in Liége, in January, 1882. His father and grandfather were goldsmiths; but the father, after Theodor was born, established a printing-office—himself, with the aid of an artisan, constructing the first press—which has become one of the most prosperous concerns of the kind in the Rhenish country. From it was issued the memorial volume published in 1879 in honor of Theodor Schwann.

The youth inherited from his father a decided taste for manual occupations, which afterward proved of great assistance to him in his laboratory work. While still a child he used to spend his play-hours in making miniature instruments of physics with the most primitive materials. From the primary school he went into

the humanitarian courses in the pro-gymnasium of his native village, and thence, for the completion of his studies, to the Jesuit College at Cologne. His lively intelligence and assiduity attracted the attention of all his teachers. He exhibited a marked predilection for mathematical and scientific studies, especially in physics.

He was still undecided as to the career he should choose, when he enrolled himself, in October, 1829, in the class in philosophy at Bonn. His family were deeply religious, and would have been glad to see him become a clergyman like his elder brother Peter, who died in 1881, Professor of Theology and honorary canon at Frauenburg. Therefore he began with a mixed course, including metaphysical and logical studies, along with those in mathematics and science. The latter branches in the end absorbed all his attention, and he decided to study medicine.

He became the pupil of the anatomist and physiologist Johann Müller, and that fixed his destiny. Müller, with a full appreciation of Schwann's abilities, made him an associate in his labors, and they experimented together on the motor and sensitive roots of the spinal nerves, and on the coagulation of the blood. Having passed the philosophical and scientific examinations at Bonn, Schwann went to Würzburg, where he passed three semesters, and then removed to Berlin to complete his studies and go through his final examinations. He found Müller here again, as Professor of Anatomy and Physiology, and under his direction performed the investigation on the necessity of oxygen to the development of the embryo in the hen's egg, on which was based his inaugural dissertation on receiving the degree of doctor of medicine.

Müller, insisting upon Schwann's following a scientific career, had him appointed in 1834 aid at the Anatomical Museum, of which he was director. The position was an extremely modest one, and not at all pleasant. The late Director of the Berlin Museum, Peters, speaks of having seen Schwann at work for whole days scraping the fins of a giant ray while preparing its skeleton; and many of the specimens in the zoölogical collections bear witness to the conscientious care with which he performed this monotonous work. The five years which Schwann spent here with Müller were a period of intense application, marked by a succession of discoveries. All the great works which illustrate his name date from this epoch.

A characteristic portrait of Schwann as he appeared at this time has been drawn by Henle, who passed several years under the same roof with him. He says: "He was a man of stature below the medium, with a beardless face, an almost infantine and always smiling expression, smooth, dark-brown hair, wearing a

fur-trimmed dressing-gown, living in a poorly lighted room on the second floor of a restaurant which was not even of the second class. He would pass whole days there without going out, with a few rare books around him and numerous glass vessels, retorts, vials, and tubes, simple apparatus which he made himself. Or I go in thought to the dark and fusty halls of the Anatomical Institute, where we used to work till nightfall by the side of our excellent chief, Johann Müller. We took our dinner in the evening, after the English fashion, so that we might enjoy more of the advantage of daylight. Our porter's wife furnished the meat, we the wine and wit. Those were happy days which the present generation might envy us; happy days when the first good microscopes had been sent out from the shops of Plössi at Vienna, or of Pistor and Schick at Berlin, which we paid for by exercising a student's economies; happy days, when it was still possible to make a first-class discovery by scraping an animal membrane with the nail or cutting it with the scalpel." Müller had at that time begun the publication of his great treatise on physiology, a work of scientific criticism into which he admitted nothing as true that had not been verified by himself or by his assistants under his eyes. Schwann, at his instigation, undertook a number of physiological and microscopical researches for this work. He examined the texture of the voluntary muscles; pointed out a method of isolating the primary fibers, and demonstrated the origin of the transverse striæ of their primitive bundles. He sought for the terminations of the nerves in the muscles, without being able to discover them. He did not accept the ansated termination, which was generally believed in then, but has now been disproved. He first determined the existence of the proper walls of the capillary vessels, and came very near discovering their endothelium. He demonstrated, by physiological experiments with cold water, the muscular contractibility of the arteries. He discovered in the mesentery of the frog and the tail of the tadpole the division of the primitive fiber of the nerves, an observation then without precedent. He first proved, by microscopical examination and by the re-establishment of the function, the restorableness of cut nerves; and he first made use of that faculty in approaching the question of learning whether the sensitive or motor fibers, when stimulated in their middle parts, propagate the irritation toward both the center and periphery at once, or only in one direction. He invented the muscular balance, for measuring the force of the muscle in different states of contraction. He demonstrated that muscular contractility follows the same law as the elasticity of a body which, having the same length as the muscle at its maximum contraction, is stretched out to the length of the muscle at rest. This work on muscular force

was the beginning of the series of researches by the aid of which Du Bois-Reymond, Helmholtz, and others have built up the general physiology of the nerves and muscles. It was the first instance, says Du Bois-Reymond, of the examination of an eminently vital force as if it were a physical one, and of the mathematical expression in figures of the laws of its action.

Schwann assisted, with the professors at Berlin, in the preparation of the Encyclopedic Dictionary of the Medical Sciences, to which he contributed the articles on vessels, hematose, urinary secretion, and cutaneous secretion. At this period, also, he began the experiments which led up to the discovery of the digestive ferment, pepsin; and the principles which he set forth on the subject are essentially the same as are still taught, the elucidation of a few details being all that has been added.

In one of the theses attached to his inaugural dissertation, Schwann had opposed the theory of spontaneous generation, which had begun to prevail again, after a general abandonment of Spallanzani's germ theory. The absence of microbes from preparations which had been hermetically sealed was attributed to the deprivation of oxygen. Schwann and Franz Schulze labored independently to disprove this view. Schulze showed that vegetable and animal infusions could be preserved for months in the presence of air and after renewing supplies of air, if the air was first passed over sulphuric acid to kill the germs in it. Schwann communicated to the Society of German Naturalists and Physicians the results of similar experiments, and of others in which he destroyed the germs by calcination. He explained putrefaction as a work of decomposition by the germs developing themselves at the expense of the organic substance, in proof of which he showed that arsenic and corrosive sublimate, which were poisonous to infusoria, were also the best preservatives against putrefaction. It remained to be shown that the calcination of the air did not deprive it of its essential properties of sustaining respiration and promoting alcoholic fermentation—for the advocates of spontaneous generation might say that the development of life was prevented by asphyxiation. Schwann's view was sustained when he found that frogs suffered no inconvenience in calcined air; but, when it came to apply the test to the fermentation of alcohol, no fermentation took place. Schwann was not discouraged by this, but proclaiming a new discovery, that yeast was an organic growth, and working out experiments to prove it, converted the apparently hostile result into an additional support to his theory. These ideas did not receive at once the support they deserved. They had a formidable adversary in Liebig, who set forth another theory of fermentation, and ridiculed them with a parody. Schwann, averse to controversy, made no answer to

Liebig's contradictions or to his joke. He bided his time. It came in a quarter of a century, when Schwann saw his theory extended to cover a great variety of chemical and pathological actions, and almost universally accepted; and received in 1878, from Pasteur, who had carried it to its highest triumph, a letter recognizing him as the one who had opened the road by following which his own wonderful discoveries were made.

These researches might of themselves have sufficed to make the name of Schwann illustrious. But they are relatively but little known because their fame has been dimmed in the face of the incomparable luster of his great discovery of the cell theory. The publication of the book in which the basis of this theory was laid down opened a new era in biological study. We might search in vain, says Simon, in his History of the Natural Sciences, for an example of a more radical revolution in the direction and character of scientific labors than that which was effected in 1838 and 1839 by the publication of Schwann's histogenetic theory. The revolution was sudden, and triumphed, we might say, without resistance. As Henle has remarked, the scientific soil in which this theory took root and grew had been prepared from two different points of view: one, philosophical or ideal; the other, positive or histological. The philosophical preparation dated from the beginning of the study of Nature, and was illustrated in the propensity of the human mind to look for some simple cause for the diversity of phenomena. To this we owe the monads of Epicurus and Leibnitz, Oken's philosophy of Nature, and many other efforts ancient and modern. On the other side, certain histological researches, often very modest, but coming close to the facts, had prepared a way for the cell theory. Robert Brown had discovered the cellular nucleus in 1831; Mirbel, Von Mohl, and Unger had demonstrated that the organs and tissues of plants were at bottom aggregations of cells in different degrees of transformation. Schleiden had been studying the important part played by the nucleus in the formation of vegetable cells, and had given it the name of cytoblast; and other authors had found in animals organs formed of cells. But these were as yet only isolated facts.

Schwann has himself told the story of the way the idea of his discovery first occurred to him. "One day," he says, "when I was dining with M. Schleiden, that illustrious botanist spoke of the important part which the nucleus plays in the development of plant-cells. I at once recollected that I had seen a similar organ in the cells of the dorsal cord, and instantly appreciated the extreme importance the discovery would have if I could show that it plays the same part there as the nucleus of plants in the development of vegetable cells. It must follow, in fact, in consequence of the identity of so characteristic phenomena, that the

cause which produces the cells of the dorsal cord could not be different from the one that gives origin to the vegetable cells." The two men went together to the amphitheatre of anatomy to examine the nucleuses in question, and Schleiden recognized a complete resemblance between them and the nucleuses of the cells of plants. "From that time," Schwann continues, "all my efforts were directed to finding proof of the pre-existence of the nucleus in the cell." And he goes on to tell how his views were confirmed as his researches advanced. At the time Schwann thus undertook to show that all the organs are of cellular origin, the structure of most of them was very imperfectly known. The application of the microscope to researches in animal histology was of recent introduction, and everything was to create. Schwann did not shrink from the tremendous task which opened up before him; and what he had done first for the cartilages and the dorsal cord, he tried in succession for all the other bodily tissues; and in all he had the joy of seeing his idea confirmed.

Schwann came upon many new discoveries in the course of these investigations. He first compared the egg to a cell, and recognized cells in the globules of the blastoderm; described the stellar pigmentary cells, the layers of the nail, the development of feathers, the nucleuses of the prisms of the enamel, those of the smooth and striated muscles, the fibers of the dental pulp, the cells destined to be transformed into fibers of the crystalline, etc. He called attention to the envelope of the nervous fibers which bears his name as the sheath of Schwann—all of which discoveries have been confirmed by modern research armed with its more perfect technic and superior instruments. The theory of the cell as the primordial element of all the tissues was hereafter to serve as the Ariadne's thread to the numerous investigators who devoted themselves to the study of morphology, and was to help them explain the infinite variety of organic forms. It gave a definite purpose to the application of the microscope to investigations in anatomy and physiology. It was the foundation of modern physiology, and all the morphological progress accomplished during nearly the past half-century has grown out from it. Except for its having familiarized the conception of the constitutional unity of living matter, and having declared the principle that every cell is the product of another cell, the doctrine of selection and descent could not, in the opinion of Edward Van Beneden, have gained ground. Its salutary influence in pathological anatomy and the advance of physiology was immediate and great. Acting in another direction, it put an end to the theory of a special vital force, which was in full sway when it was first promulgated, and raised up that of physico-chemical action, which has taken its place. How was it possible to reconcile the notion of cellular

individuality with the existence of a single vital force, presiding over the working of all the functions? It would be necessary to reject such a hypothesis and seek the reason of vital phenomena in the properties of molecules and atoms, or else to assign a vital force in miniature to each cell. Schwann insisted that the hypothesis was both superfluous and insufficient. He could not conceive its existence unless it possessed the attributes of intelligent beings; and preferred to seek the cause of the final purpose in nature in the Creator rather than in the creature.

Schwann was just putting in press the book containing his microscopical researches and his later results, when he was invited, in his twenty-ninth year, to take the place of Windischman as Professor of Anatomy at Louvain. His position at Berlin was pleasant, but overmodest, and offered no near prospects for promotion. So he accepted the proffer, and prepared at the end of 1838 to remove. He had to meet a considerable difficulty, in the beginning of his career at Louvain, from the necessity of speaking in French; but his lectures were successful, and still form the basis of instruction in microscopic anatomy at the university. During his term here he published a memoir on the uses of the bile, the results of which, while it gave a new operation in physiological technics, have not been fully confirmed; applied Quetelet's method of statistics to physiological phenomena; and attempted the artificial production of organic elements.

In 1848, Spring, of the University of Liége, finding the combined labors of the chairs of Physiology, General Anatomy, and Comparative Anatomy too much for a single professor to perform, asked to be relieved of a part of his burden. Schwann was selected to fill the place, and was installed in November of the same year Professor of Anatomy, Spring reserving to himself the branches of osteology and myology till 1853, when the whole course came under Schwann's charge. Some opposition was expressed at first to the coming of a stranger to the university; but this soon passed away, for the brilliant reputation of the new professor, the excellence of his teaching, and the loyalty and amenity of his disposition silenced hostile comment, and won hearts to him. In later years he refused several offers of brilliant scientific positions in Germany—from Breslau in 1852, Würzburg and Munich in 1854, and Giessen in 1855. In 1858 he exchanged the chair of Descriptive Anatomy for that of Human Physiology, and in 1870 became an emeritus professor.

Clearness, order, and method are described by those who attended his lectures as the characteristic qualities of Schwann's teaching. His courses in physiology were eminently demonstrative and experimental. Laboratory work always presented a great attraction to him. He was interested in the development of

scientific technics, and regularly made himself acquainted with new instruments and methods. He had qualities of heart corresponding with the superiority of his mind. His pupils recollect the quiet good-will and fatherly kindness which he showed toward them, and returned them with grateful demonstrations.

Although he was actively engaged in scientific pursuits during the whole of his long career, he never mingled in the discussions of the learned world after he went to Belgium. During the five years of his residence in Berlin, his discoveries followed upon one another like the explosions of a piece of fire-works; and all the great discoveries that made his name illustrious and opened new horizons to scientific thought date from that time. After removing to Belgium, he published only one work, his researches on the uses of the bile. He became almost forgotten outside of Belgium, and many, not hearing his name mentioned any more, thought he was dead. This may be charged to his aversion to personal controversy. While the cell theory, as a whole, was established, some of the details gave rise to disputes in which he did not care to engage. Believing that he had reached an ultimate principle which time would only establish more strongly, he was willing to let details take care of themselves. But he never lost his interest in the scientific movement; and, at the time of his death, he was engaged in studying the influence of electrical discharges on the development of the lower beings in organic infusions.

In Schwann's theory all the phenomena of life were explained by the properties of atoms. The cell was an aggregation of atoms obeying the laws of nature as if it were a crystal. Plants and animals were aggregations of cells, likewise machines destitute of spontaneity. But man differed from animals by possessing an immaterial element that lifted him above them and gave him freedom. It was in this way that he escaped materialism, and kept himself in line with the Church, to which he submitted his studies, having even sought and obtained ecclesiastical approval for the cell theory before he would publish it. For many years he was collecting materials for a great philosophical work in which the cell theory should take the proportions of a general theory of organisms. Beginning with the definition of the atom, his Theoria, as he called it, was to include all the manifestations of life. Psychological phenomena and the dogmas of the Catholic religion were to have definite places in it. Death prevented his beginning the final preparation of it; and his heirs could only find in his desk a manuscript of seventy-two sheets entitled Man considered from the Physiological Point of View, as he is, and as he is to be.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

CORRESPONDENCE.

SIDENT HILL'S DEFENSE.

...lar Science Monthly:

SIR: In the April number of ... magazine you say that a sen... ...d from me by Bishop Vincent ...utauquan "is absolutely without ..." The objectionable sentence is, ...nselors, like Herbert Spencer, ad... ...ollow our own self-interest, with... ...n for others, with the assurance ... thus be happier, because more ...t." The quotation is made from ... of lectures on The Social Influ... ...ristianity. It is I rather than ...cent who should "either justify ...statement in regard to Mr. Spen... ...draw it." My respect for Mr. ...bility as a thinker and his sin... ...man is so great that I should ...ithdraw a statement that I felt ...ted him to those who may not ...igh opinion of him. In seeking ...stice to Mr. Spencer, I trust you ...ly the *lex talionis* to those who ...o you to do him wrong.

...tence which you condemn as "ab... ...hout foundation" occurs after a ... "undiscriminating charity" in ...tion of wealth, and the citation ...here the literal interpretation of ...rds, "Give to him that asketh ...o the demoralization of a parish. ...is to this extreme I name Mr. ...a representative of what I con... ...posite extreme—the emphasis of ...f course, I do not mean that Mr. ...vocates an absolute and unquali... ...ness, *taking no account of the ...hers.* His teaching is, that there ...anent supremacy of egoism over ... that "each creature shall take ... and the evils of his own nature, ...ived from ancestry or those due ...oduced modifications," and that ...laims must take precedence of ...laims" (Data of Ethics, pp. 186, ... He advances two suppositions: ...ach citizen pursues *his own* hap... ...pendently, not to the *detriment* ... but *without active concern for* ...nd (2) "that each, instead of ... own happiness the object of ...kes *the happiness of others* the ...ursuit"; and argues that the ... happiness would not be greater ...d ease (Data of Ethics, p. 227). ...consistency" in the doctrine ex... ... the Christian maxim—"Love ...or as yourself" (Data of Ethics, ...His conclusion is that "general ...s to be achieved *mainly* through ...e pursuit of *their own* happiness-es by individuals; while, reciprocally, the happinesses of individuals are to be achieved in part by their pursuit of the general happiness" (Data of Ethics, p. 238). Is not the center of concern here for each one *his own* happiness, with only *so much* regard for the happiness of others *as is likely to reflect happiness upon himself?*

Mr. Spencer also says: "The poverty of the incapable, the distresses that come upon the imprudent, the starvation of the idle, and those shoulderings aside of the weak by the strong, which leave so many 'in shallows and in miseries,' are the decrees of a large, far-seeing benevolence. It seems hard that an unskillfulness which with all his efforts he can not overcome should entail hunger upon the artisan. It seems hard that a laborer incapacitated by sickness from competing with his stronger fellows should have to bear the resulting privation. It seems hard that widows and orphans should be left to struggle for life or death. Nevertheless, when regarded not separately, but in connection with the interests of universal humanity, these harsh features are seen to be full of the highest beneficence—the same beneficence which brings to early graves the children of diseased parents, and singles out the low-spirited, the intemperate, and the debilitated as the victims of an epidemic" (Social Statics, p. 354). In the foregoing paragraph Mr. Spencer has included types of all the objects of human charity. He himself says (p. 356): "At first sight these considerations seem conclusive against *all* relief to the poor—voluntary as well as compulsory; and it is no doubt true that they imply a condemnation of whatever private charity enables the recipients to elude the necessities of our social existence." He "makes no objection" to "helping men to help themselves," "countenances it rather," but he shows no concern for those who need our charity because they *can not* help themselves.

In another book he says, "It may be doubted whether the maudlin philanthropy which, looking only at direct mitigations, persistently ignores indirect mischiefs, does not inflict a greater total of misery than the extremest selfishness inflicts" (The Study of Sociology, p. 345). But all charity inspired by personal sympathy looks mainly to "direct mitigations," and overlooks those "indirect mischiefs" which the aid of the inferior is likely to produce. The "extremest selfishness" would seem from this presentation to be better than interference with that "large, far-seeing benevolence" which Mr. Spencer sees in the operation of the law of consequences.

I am not alone in my view of Mr. Spencer's teaching upon this point. In his criticism of The Man *versus* the State, in The Popular Science Monthly, vol. xxvii, p. 170, Prof. de Laveleye says, "The law that Mr. Herbert Spencer desires to adopt is simply Darwin's law—the survival of the fittest." On page 172, after citing a passage explaining the manner in which natural selection among animals is accomplished, M. de Laveleye adds, "This is the ideal order of things which, we are told, ought to prevail in human societies." In his Rejoinder Mr. Spencer evades this by saying that his Social Statics was written in 1851, while Darwin's Origin of Species was written in 1859. This is satisfactory so far as the expression "survival of the fittest" is especially "Darwin's law," but the principle is involved in the operation of the "large, far-seeing benevolence" which kills off the weak and helpless, by whatever name it is designated. Mr. Spencer does not seem to complain of M. de Laveleye's imputation, if the latter means "the survival of the industrially superior, and those who are fittest for the requirements of social life." I understand Mr. Spencer to oppose carrying the struggles of the "tooth and claw" period into our industrial era, but that he is willing to permit the operation of the principle of natural selection with more civilized weapons.

In his Rejoinder to M. de Laveleye, Mr. Spencer, after speaking of the distribution of aid by the Government, says, "If others, in their private capacities, are prompted by affection to pity or to mitigate the evil results, by all means let them do so"; but this assumes the tone of mere sufferance when he immediately adds: "No power can equitably *prevent* them from making efforts, or giving money, to diminish the sufferings of the unfortunate and the inferior; at the same time that no power can equitably coerce them into doing so." I understand this to mean that there is no right in the state to interfere with private charity, if any one is moved to it. In another place Mr. Spencer says (p. 189), "Without wishing to restrain philanthropic action, but quite contrariwise, I have in various places argued that philanthropy will better achieve its ends by non-governmental means than by governmental means." I understand by this that Mr. Spencer has no wish to "*restrain*" philanthropy, and he believes the voluntary form better than the compulsory; but he does not claim any wish to *promote charity*, and the kind of "philanthropy" he has in mind seems to be only such as is consistent with his other doctrines. As he views it, true philanthropy is best expressed by non-interference. The greatest happiness is worked out by the law of consequences, which in reality is a "large, far-seeing benevolence." "Inevitably, then, this law in conformity with which each member of a species *takes the consequences of its own nature;* and in virtue of which the progeny of each member, participating in its nature, also takes such consequences: is one that *tends ever to raise the aggregate happiness of the species* by furthering the multiplication of the happier and *hindering that of the less happy*. All this is true of human beings as of other beings" (Data of Ethics, p. 190).

I have tried to present the grounds on which my statement regarding Mr. Spencer rests. I think he means to encourage self-reliance as the primary virtue of humanity, and that he seriously believes that what is known in the world as "charity" weakens it. The question is not now whether he is right or wrong, but whether or not this is his teaching. I am aware that my words can be so interpreted as to represent Mr. Spencer as indifferent to human beings other than himself, but that is not my meaning. He distinguishes between acting "*to the detriment of others*" and acting "*without active concern for others*" (Data of Ethics, p. 227), and I use the words "without concern for others" in his own sense. If you think the word "active" modifies the meaning in any important way, I am willing to introduce it in my sentence, if I can be assured that "concern," which is but passive and not active, has any meaning. Otherwise the expression "active concern" is a pleonasm.

Mr. Spencer's doctrine is, as I interpret it, that, if each looks out well for himself, then all will be happy, at least as soon as "adaptation" has been realized; and until it has, no amount of solicitude for others or sacrifice in their behalf can possibly realize their happiness.

Very respectfully yours,

DAVID J. HILL.

UNIVERSITY OF ROCHESTER,
ROCHESTER, N. Y., *April* 12, 1890.

THE SUSPENSION BRIDGE.

Editor Popular Science Monthly:

SIR: In reply to the letter of Mr. Gustav Lindenthal (vol. xxxvi, page 844), criticising my remarks as to the lack of stability of suspension bridges (page 478), I would like to make the following statement:

I do not consider it at all necessary that my remarks upon any of the different types of bridges should be followed by the words "as usually built," as, from the title of the article, The Evolution of the Modern Railway Bridge, I could not possibly refer to any mode of construction other than that in general use or some antiquated method.

I did refer to the suspension bridge as "usually built," and as such it is very deficient in rigidity, and in practice it has been found almost impossible to so brace it laterally and vertically as to render it in any way a desirable bridge for the passage of our modern heavy trains at a high rate of speed.

I refer simply to the suspension bridge up to its present point of evolution, both as

to length of span and method of construction, and not to the possible suspension bridge of the future.

In regard to the remainder of Mr. Lindenthal's letter: A bridge to be stable and rigid, in the engineering meaning of the words, must be so designed that under any probable form of loading no change of form can take place, either in the bridge as a whole or any of its parts, other than that due to the elasticity of the material used.

The suspension bridge, as we know it, consists of a flexible chain or cable from which the roadway is hung: given a sufficiently heavy moving load relative to the dead weight of the bridge, and the form of the curve assumed by this chain or cable will change with each change in the position of the load, and the bridge can not be called stable.

The mere fact that the inverted arch is in stable equilibrium while the upright arch is not, has absolutely no bearing upon this question, when we consider the form of the materials that are used in each case. I admit that, if the steel arches of the St. Louis Bridge were inverted and braced and counterbraced in a manner similar to that made use of at present, the bridge would be as stable, etc., as the present bridge; but certainly not if the vertical and lateral bracing were dispensed with, and simply a chain substituted for the present compression arch.

It is, however, impossible to state the relative merits of different bridge designs without taking into account the length of span; and to a great extent the question is decided by the relation that exists between the dead load, consisting of weight of the bridge, and the live load, consisting of the passing train, etc. The following may be taken as the maximum economic lengths for railway bridges of iron or steel:

Plate girders	50 feet.
Riveted lattice	150 "
Pin-connected with parallel chords or arched top chord	550 "
Cantilever	1,750 "
Suspension, over	1,750 "

When the suspension bridge reaches such a size that the weight of any probable load that may come upon it is nothing as compared to its own weight—as would be the case in the proposed suspension bridge extending from New York to Jersey City, designed by Mr. Lindenthal, with a central span of 2,850 feet—then much that has been said here in regard to the instability of suspension bridges will not apply, owing to the fact that under no circumstances would it be possible to so load a bridge of such dimensions that the load would bear even an appreciable value to its own weight.

One word more in regard to "the popular and fashionable misconception as to the merits of the cantilever bridge." Its greater deflection is due simply to the fact that it is in the form of a girder fastened at one end and strained over a pier, and does not amount to a demerit in the principle.

If I understand Mr. Lindenthal's use of the expression "all other things being equal," etc., correctly to mean vertical and lateral bracing, etc., practically everything never could be equal; and the cantilever bridge, *within the limits of span given*, is in every way superior to the suspension bridge as a modern railway bridge. Respectfully,

CHARLES DAVIS JAMESON.

IOWA CITY, *April* 8, 1890.

EDITOR'S TABLE.

DOES MR. SPENCER INCULCATE SELFISHNESS?

WE print in our present number a letter from President David J. Hill, of the Baptist University of Rochester, in which an attempt is made to justify the statement contained in his book on the Social Influence of Christianity, and reproduced, with the sanction of Bishop Vincent, in The Chautauquan, that Mr. Spencer "advises us to follow our own self-interest, without concern for others, with the assurance that all will thus be happier, because more independent." If such a statement could be justified, President Hill would doubtless be highly qualified to perform the task. He has a high respect, he tells us, for Mr. Spencer's "ability as a thinker and sincerity as a man"; and we may presume that this high opinion has not been formed without adequate study of Mr. Spencer's works—such a study as would give ample command of illustrative passages in such a discussion as the present. The question now is: Has President Hill proved his case? Has he justified the damaging remark made by him in regard to Mr. Spencer's ethical system? We venture to say that he has not done so, but, on the contrary, has signally failed in his attempt. The reason is, that the facts are against him. Whether he is fully aware how much

the facts are against him is a question we do not undertake to decide; but it seems to us hardly probable that he would even try to maintain his present position if thoroughly informed on the point at issue.

Dr. Hill tells us that, in the lecture in which the passage challenged by us occurred, he was drawing attention to the two hurtful extremes of undiscriminating charity and complete egoism, as represented by Herbert Spencer; and that it was thus that he came to say that "some counselors, like Herbert Spencer, advise us to follow our own self-interest without concern for others, with the assurance that all will be thus happier because more independent." The intention to make Mr. Spencer the representative of a more or less repulsive moral doctrine is thus avowed. What, then, is the proof that Mr. Spencer advocates any such doctrine? Dr. Hill points us to a passage in which Mr. Spencer uses *some of the words* employed to summarize his teaching. But, in the passage in question (Data of Ethics, page 227), Mr. Spencer is not giving any counsel; he is simply making two suppositions and drawing a conclusion from each. These are his words: "Suppose that each citizen pursues his own happiness independently, not to the detriment of others, but without active concern for others; then their united happiness constitutes a certain sum—a certain general happiness. Now suppose that each, instead of making his own happiness the object of pursuit, makes the happiness of others the object of pursuit; then again there results a certain sum of happiness." He goes on to show that it is impossible any general gain could result from the neglect of one's own happiness in the pursuit of that of others. What proof is there here that he would not wish us to interest ourselves in the welfare of our neighbors? The whole drift of the chapter (entitled Trial and Compromise) in which the above passage is found is to show that absolute egoism and absolute altruism alike defeat the ends in view: the absolutely egoistic man fails to make himself happy, and the absolutely altruistic man fails to make others happy; *therefore*, some compromise between the two principles is necessary. Not to go any further than this we find Mr. Spencer's position sufficiently defined. He does not stand, as Dr. Hill would have his readers believe, for "the emphasis of egoism": what he emphasizes, and that over and over again, is the necessity for a due blending of egoism and altruism.

But Dr. Hill has other proofs. He quotes Mr. Spencer as saying that there is "a permanent supremacy of egoism over altruism." True; and how does Mr. Spencer explain the words? Let us quote: "The acts by which each maintains his own life must, speaking generally, precede in imperativeness all other acts of which he is capable. . . . The acts required for continued self-preservation, including the enjoyment of benefits achieved by such acts, are the first requisites to universal welfare. Unless each duly cares for himself, his care for all others is ended by death; and if each thus dies, there remain no others to be cared for." Then follow the words which Dr. Hill relies on to help his case: "This permanent supremacy of egoism over altruism is further made manifest," etc. Now, here we have it fully explained that by "supremacy" is meant priority in time and precedence in biological importance. How is this to be twisted into an exhortation "to follow our own self-interest, without concern for others"?

Dr. Hill further asserts Mr. Spencer's teaching to be that "each creature shall take the benefits and evils of its own nature, be they those derived from ancestry or those due to self-produced modifications." This is not quite correctly put, though the error is probably not intentional on Dr. Hill's part. Mr. Spencer does not say that "each creat-

ure shall," etc., but that *there is a law in nature*, which, however it may be qualified, can not be essentially changed, *that* "*each creature shall*," etc. The distinction is not without importance; as quoted by Dr. Hill, Mr. Spencer seems to be laying down a law in the spirit of a legislator, whereas he is only announcing a law in the tone of a discoverer. Now, if Dr. Hill does not believe there is any such law as Mr. Spencer announces and formulates, let him say so; the controversy will then turn on the interpretation to be given to the history of mankind. But, again, let Mr. Spencer explain himself: "Any arrangements which in a considerable degree prevent superiority from profiting by the rewards of superiority, or shield inferiority from the evils it entails—any arrangements which tend to make it as well to be inferior as to be superior—are arrangements diametrically opposed to the progress of organization and the reaching of a higher life." Is this true or not? Again, is it true, or not true, that "general happiness is to be achieved mainly through the adequate pursuit of their own happiness by individuals; while, reciprocally, the happinesses of individuals are to be achieved in part by their pursuit of the general happiness"? We say it is true; but we do not agree with Dr. Hill, who says that "the center of concern for each one is here his own happiness, with only so much regard for the happiness of others as is likely to reflect happiness." Mr. Spencer is not discussing "the center of concern," but the best conditions for the production of general happiness; and his position can only be traversed by showing that the conditions he asserts to be the best are not the best. Unless this can be done, what is the use of talking about "the center of concern"? It will be observed by the careful reader that what Mr. Spencer postulates in the first half of the above sentence is *adequate* pursuit of one's own happiness. The word is well and happily chosen, and gives the key, we may say, to the whole thought of the writer on the point involved. The adequate pursuit of one's own happiness is one thing; the inordinate or selfish pursuit of it is quite another.

Dr. Hill quotes a passage from Social Statics, and draws from it the conclusion that Mr. Spencer "shows no concern for those who need our charity because they can not help themselves." The conclusion is not justified, in our opinion, by the text. On the contrary, the whole passage is expressive of sympathy with suffering, and there is nothing in Mr. Spencer's system to check the relief of suffering except where to do so would be to entail greater subsequent suffering. Quoting from Mr. Spencer a passage in which he says, "Without wishing to restrain philanthropic action, but quite contrariwise," etc., Dr. Hill comments on it as follows: "I understand by this that Mr. Spencer has no wish to restrain philanthropy; but he does not claim any wish to promote charity." We certainly do not so understand the words "quite contrariwise"; we think they *do* imply a desire on Mr. Spencer's part to promote any charity that will be truly philanthropic and not hurtful in its effects. "As he views it," says Dr. Hill, "true philanthropy is best expressed by non-interference." Mr. Spencer has never said anything to justify this remark; but he has said that non-interference is better than a good deal of the interference that calls itself charitable. Dr. Hill tells us in conclusion that he is aware that his words—those referred to by us last month—"can be so interpreted as to represent Mr. Spencer as indifferent to human beings other than himself; but that," he adds, "is not my meaning." If Dr. Hill was aware, when he penned the words in question, that they could be so interpreted, he should in common fairness have guarded against such a misapprehension. If, on the other hand, he has only now become aware that they are open to a wrong interpretation, he should hasten to say

that he should not have used such words.

Up to this point we have been examining what Dr. Hill offers as his proofs that Herbert Spencer advises us "to follow our own interest without concern for others"; it remains now to glance at a few of the numerous passages which show in the most positive and conclusive manner that Herbert Spencer holds no such principle as that imputed to him, but, on the contrary, earnestly desires that we should concern ourselves for one another, and that sympathy should govern in all human relations. It is very singular indeed that these passages should have missed, if they did miss, Dr. Hill's scrutiny; and more singular still, if he was cognizant of them, that he should not have considered that any of them had a bearing on the question at issue. We must devote the remainder of our space mainly to quotations. To show what he understands by moral motives, Mr. Spencer says (Data of Ethics, page 121): "The man who is moved by a moral feeling to help another in difficulty, does not picture to himself any reward here or hereafter, but pictures only the better condition he is trying to bring about. One who is morally prompted to fight against a social evil has neither material benefit nor popular applause before his mind; but only the mischiefs he seeks to remove, and the increased well-being which will follow their removal." Then take the following as indicating his ideal of social life: "A society is conceivable formed of men living perfectly inoffensive lives, scrupulously fulfilling their contracts, and efficiently rearing their offspring, who yet, yielding to one another no advantages beyond those agreed upon, fall short of that highest degree of life which the gratuitous rendering of services makes possible. . . . The limit of evolution of conduct is consequently not reached until, beyond avoidance of direct and indirect injuries to others, there are spontaneous efforts to further the welfare of others" (Data of Ethics, page 147). "Sympathy is the root of both justice and benevolence" (do., page 148).

Any one wishing to know what scope Mr. Spencer allowed to the altruistic principle would naturally turn to the chapter in his Data of Ethics entitled Altruism *versus* Egoism. Dr. Hill did not find it in the interest of his argument to make any quotations from that chapter; we must, therefore, be allowed to produce a few: "That any one should have formulated his experience by saying that the conditions to success are a hard heart and a good digestion is marvelous, considering the many proofs that success, even of a material kind, greatly depending as it does on the good offices of others, is furthered by whatever creates good-will in others. The contrast between the prosperity of those who to but moderate abilities join natures which beget friendships by their kindliness, and the adversity of those who, though possessed of superior faculties and greater acquirements, arouse dislike by their hardness or indifference, should force upon all the truth that egoistic enjoyments are aided by altruistic actions. This increase of personal benefit achieved by benefiting others is but partly achieved where a selfish motive prompts the seemingly unselfish act; it is fully achieved only when the act is really unselfish. . . . Those (services) which bring more than equivalents are those not prompted by any thoughts of equivalents. For obviously it is the spontaneous outflow of good nature, not in the larger acts of life only, but in all its details, which generates in those around the attachments prompting unstinted benevolence" (page 211). Not bad for a man who is credited in an article written by a college president, and selected by a bishop for the reading of young people whose opinions are in course of formation, with advising us "to follow our own interest without concern for others"! Not so bad this either: "If we contrast early poetry, occupied mainly

with war and gratifying the savage instincts by descriptions of bloody victories, with the poetry of modern times, in which the sanguinary forms but a small part, while a large part, dealing with the gentler affections, enlists the feelings of readers on behalf of the weak, we are shown that, with the development of a more altruistic nature, there has been opened a sphere of enjoyment inaccessible to the callous egoism of barbarous times" (page 215). We have marked many other passages for quotation, not in the Data of Ethics alone, but in other works of Mr. Spencer's as well, but our limits forbid the use of them. Enough has been produced, however, to prove to any unprejudiced reader that the accusation brought against Mr. Spencer of counseling selfishness is, as we said before, "absolutely without foundation," and does signal injustice to a man the whole of whose philosophy is so strongly inspired by a social motive. In the matter of moral science many people are today in the position in which men in general were some generations ago in relation to physical science. Just as the alchemists of a former time were bent on achieving the transmutation of metals, and the astrologists on reading in the stars the destinies of individuals and of states; and just as these precursors of the scientific workers of our time would have been greatly discouraged and would perhaps have abandoned their labors if persuaded that their methods were vain and their hopes visionary and unrealizable; so, if we may be allowed to say so, the pre-scientific or anti-scientific moralists of our own time are disposed to spurn any ethical system that is not transcendental in its character and does not nourish boundless hopes. Truth, however, is making its way in the world; and gradually all intelligent men will be led to see that better, wider, and more permanent results can be achieved by working on the moral lines laid down by science, than by striving, with the older philosophies and theologies, to scale the heaven of an unattainable virtue. Let us hope that the present discussion may have a little influence in this direction.

LITERARY NOTICES.

JOURNAL OF RESEARCHES INTO THE NATURAL HISTORY AND GEOLOGY OF THE COUNTRIES VISITED DURING THE VOYAGE ROUND THE WORLD OF H. M. S. BEAGLE, UNDER THE COMMAND OF CAPTAIN FITZ ROY, R. N. By CHARLES DARWIN. A new edition, with Illustrations. New York: D. Appleton & Co. Pp. 551, with Maps. Price, $5.

THERE are only a few books that have the qualities of an originality and freshness that never wear out. Darwin's Naturalist's Voyage must be conceded a prominent place in the list. It has been a little more than fifty years since it was first published. That is a very long time in the life of a book of science and even of a book of travels. Either is likely to become antiquated and obsolete in that period. The book of science comes to be read largely as a curiosity, and to derive its chief interest as being a landmark from which the advance accomplished may be measured. The book of travels becomes a kind of history, and is valued for the illustrations it furnishes of the scenes and conditions that once prevailed. Mr. Darwin's Journal, in whichever aspect we regard it, seems as life-like, real, and sagacious as if it were the fresh record of the latest observer. The prediction made by the Quarterly Review on its first appearance, that "it must always occupy a distinguished place in the history of scientific investigation," is more than fulfilled. The work accomplished by Darwin on this voyage has been gone over, in its various parts, many times, with all the advantages of increased knowledge and approved appliances and methods of investigation; and it is surprising how little of it has to be rewritten. So far from any of its science seeming obsolete, we find all through the narrative observations which are in effect unconscious predictions, the product of the author's peculiar way of looking at things, of what has since been determined; and we are also constantly reminded that the later determinations are to

the largest extent the outcome of Mr. Darwin's own subsequent work. The track of the voyage and its principal features are well known to all persons who are conversant with the scientific literature of the last half-century, for hardly any book has been more frequently referred to in that literature. The places visited were not as familiar then as they have since been made, and of the natural life of many of them hardly anything was known. So Mr. Darwin enjoyed the advantage of being one of the first visitors and often the first scientific observer. Much of the book is, therefore, the original record by a discoverer of his discovery. Of the manner in which that record has been composed, we need say no more than quote Mr. John Murray's remark in the Prefatory Notice to the present edition, that "the extraordinary minuteness and accuracy of Mr. Darwin's observations, combined with the charm and simplicity of his descriptions, have insured the popularity of this book with all classes of readers, and that popularity has even increased in recent years." Not only are Mr. Darwin's observations as a rule accurate and anticipatory of much that has since been established; they also comprehend nearly everything that should fall under the ken of a thorough-going investigator. Seeing all that the experienced traveler sees and a great deal more than most of this class think of looking for, he portrays the scenery with a few well-defined traces; studies the geology; looks after the animal and vegetable life, with an eye that discerns as much in a few hours of sojourn at a place as duller observers might hardly discover after months of study; peers with equal keenness into the habits and most trifling actions of the animate world; takes note of the human life, of society, of manners and customs, the conditions of civilization, and of the prospects for the future of the countries he visits; and interweaves the whole with pertinent yet undogmatic speculations as to the meaning of the various features that came under his eye such as mark all the man's work—most of which have been verified, or are in course of verification by investigations to which he gave the start and on lines of research which he himself marked out. Perhaps the point to which the present interest is attached is embodied in his observations on coral reefs, which have come under discussion again in consequence of the new results obtained by the Challenger Expedition. Some of his observations—in cases where the aspect is affected by the progress of human settlement—are in more or less striking contrast with what is to be seen now. One of the strongest contrasts, perhaps, is offered in the picture of New Zealand, where the natives at the time of his visit lacked the charming simplicity of the Tahitians, and the greater part of the English were "the very refuse of society." But in the more detailed fillings of even this picture we find foreshadowings of the higher civilization that has overtaken the Maoris, and the prosperity that has attended the English colony. The present edition of Mr. Darwin's narrative is illustrated by views not in the previous editions, most of which were made on the spot by Mr. R. T. Pritchett with the book by his side, and others are taken from engravings which Mr. Darwin himself had selected for their interest as illustrating his voyage.

North American Geology and Paleontology. For the Use of Amateurs, Students, and Scientists. By S. A. Miller. Cincinnati. Pp. 664.

This work includes a summary of the general principles of geology, with definitions of the principal formations represented in North America, and a manual of Palæozoic paleontology. The first chapter, on the "Definitions and Laws of Geology," concisely presents the principles of geological theory, including the agencies by which the structure and appearance of the superficial crust of the earth are affected; explanations of the more general terms used in geology, and remarks on the principles of nomenclature. For the systems, the generally accepted names are used. In choosing between the methods that have been followed in naming the groups, a preference is expressed for calling each group after the place in which the strata were first studied and described, because a name thus formed is sufficiently technical; it can not be used for any other purpose; and it indicates the typical locality of the exposure. On the other hand, names founded on the mineralogical

or other special character of the exposure may prove inapplicable to the representative of the same group in some other situation. The systems, as they are known in North America, are then described in their order, beginning with the Laurentian, in the first ninety pages; and the typical localities and general extent of each are noticed. The rest of the volume is occupied with the paleontological manual; and this is introduced with an ample exposition of the rules of nomenclature. The list is classified, beginning with the plants, and passing through the animal orders to the batrachians, each sub-kingdom and class being introduced by a text describing its characteristics and its orders. The names of all the species, arranged in alphabetical order, are given under the genera to which they belong, with the authors of them, the dates of publication, and, frequently, references to two places of publication. The cases are marked when generic and specific names are not known to occur in the Palæozoic rocks of North America; of synonyms, names not described as required by the rules of nomenclature, preoccupied names, and names condemned for any other reason; and erroneous references of species to genera are pointed out and corrected. A large proportion of the genera are illustrated by engravings of typical species.

FORT ANCIENT. THE GREAT PREHISTORIC EARTHWORK OF WARREN COUNTY, OHIO. Compiled from a Careful Survey, etc., by WARREN K. MOOREHEAD. Cincinnati: Robert Clarke & Co. Pp. 129, with Plates and Map.

FORT ANCIENT is a very extensive and important "mound-builders'" earthwork, overlooking the Little Miami River and its railroad, a few miles above Cincinnati. It is described by the author as "the greatest of all prehistoric earthworks in the Mississippi basin." Mr. Moorehead conceived that a full account of so remarkable a structure was desirable, and prepared himself conscientiously to furnish it. The first step was to make a survey, and for this, with a corps of competent workers, he went over the entire structure many times, and carried on a work which, he trusts, will need no additional researches to complete. In this he was assisted by Mr. Gerard Fowke and Mr. Clinton Cowen. The main purposes of the writer have been to set before the public, in as brief and exact a manner as possible, the prominent features and wonders of the monument, and to insist upon its purchase and preservation by some historical or scientific association. The fort is situated upon a plateau standing close to the river-bank, at a height of 269 feet above low water, and about 900 feet above the level of the sea. The irregular contour of the work is 18,712 feet in length, but a diameter drawn from north to south is only 4,993 feet long. The structure consists of two large inclosures, called the old and new forts, connected by a narrower passage-way which the author calls the isthmus. At the southern end of the isthmus, where it is narrowest, is the "great gateway," guarded by a mound on either side. Opposite it, at about one third of the length of the isthmus, is the "Crescent Gateway." The space between these gateways is called the "Middle Fort," and appears to have been the strongest part of the work. Numerous graves, skeletons, and remains of human work were found in and around the fortifications, and evidences of an ancient village site in the valley. The whole proves to the mind of the author that Fort Ancient was built for defense; that it was a rallying-point for a large population inhabiting a district of considerable extent, and was often the scene or the witness of fierce battles. It may have been used as a fortified village site, with people living within its walls all the time—not enough to command the inclosure, but enough to keep it in good repair. A high opinion is expressed of the ability of the constructors. They showed extraordinary patience, and "have left evidence of the possession of qualities seldom found among savages. They engineered the position of the walls with reference to the most secure places with admirable skill." With no tools, such as we use, and wicker baskets and skins as the only means of conveyance, by mere strength of hand and back, they accomplished a work before which we, even with our modern implements, would hesitate. The selection of the site, "the best for the purpose which the valley of the Ohio offers"; the skill with which the walls were carried around the entire inclosure; the care with which weak and exposed points have been

strengthened; the lookout mounds; their skulls, etc., indicate for them a higher place in the scale of being than the majority of the tribes and remnants of tribes whom the white settlers of western Ohio found there. Mr. Moorehead believes they were Mandans.

FIFTH ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY, 1883–'84. By J. W. POWELL, Director. Washington. Pp. liii + 564.

THIS handsome volume gives ample evidence as to the active prosecution of the work of the Bureau of Ethnology during the year that it covers. The director reports that the field-work of 1883–'84 embraced explorations of mounds in several States east of the Rocky Mountains; explorations of ruins in Arizona and New Mexico; further researches among the Zuñi, by Mr. Cushing; and studies of signs, languages, and myths in various localities. At the same time office-work in preparing for publication materials already gathered was being vigorously carried on. The first of the papers accompanying the director's report is on Burial Mounds of the Northern Sections of the United States, by Prof. Cyrus Thomas, and was noticed in this magazine in March of last year. There is a paper by Mr. Charles C. Royce, on the Cherokee Nation of Indians, being a narrative of their official relations with the colonial and Federal governments. This record gives attention in orderly sequence to the historical traditions of the Cherokees, to their early contacts with explorers and colonists, to successive treaties and cessions of territory, with the events leading thereto, and the ensuing results. Through the paper appear biographical notices, accounts of the trials and struggles due to deportation and conflict, and many interesting facts showing the persistent advance of this intelligent people in civilization, numbers, and prosperity. The paper is accompanied by two large folded maps showing the former and present boundaries of the territory occupied by the Cherokees, also by a map of the year 1597, being the earliest which shows their location. The Mountain Chant, a Navajo ceremony, is described by Dr. Washington Matthews. The essay is divided into a translation of the myth on which the ceremony is based, an account of the nine days' exercises, and the originals and translations of the songs and prayers used in the course of the ceremonial. Four colored plates representing pictures made on the ground with colored powders, and many cuts showing implements and actions employed during the course of the rites, illustrate the paper. An account of the arts and customs of the Seminole Indians of Florida, with illustrations, is contributed to the volume by the Rev. Clay MacCauley. Mrs. Tilly E. Stevenson describes The Religious Life of the Zuñi Child, which includes a ceremony, performed before the child is four years old, by which he is supposed to receive the sacred breath of supernatural beings. The colored masks worn by the boys, and the colored figures made on the ground in this ceremony, are represented on lithographic plates.

HISTORY OF EGYPT. By F. C. H. WENDEL. New York: D. Appleton & Co. (History Primers.) Pp. 159. Price, 45 cents.

THE author's purpose in preparing this little book has been to give a brief account of Egyptian history which would be as reliable as the present state of Egyptological science presents, and to create a deeper interest in the study of ancient Egypt. He rightly believes that this study is of the greatest value, and of an importance that is growing more manifest every day to the student of almost every branch; for in it probably lie, at least in a large part, the foundations of our science and art. The story is told in a careful, scholarly manner; bears the marks of a thorough study and preparation; and is brought up as nearly to the latest discovery as is practicable in a book which requires time to pass through the press. For sources of information the Egyptian monuments are almost wholly relied upon —thus securing the correctness that is derived from contemporary records. The vexed question of chronology is ingeniously solved, or rather cut, by adopting Eduard Meyer's plan of "approximate dates," or of giving the latest date that can be assigned to the era, and leaving it understood that it is impossible to determine how much earlier the event may have taken place. This date, for the accession of Menes, is about 3200 B. C. The book supplies a real want of a compact,

popular history of this most ancient of nations, in the light of the latest researches. While we accept as valid the author's reason for not including the science, art, and literature, as well as the dynastic history—that the space contemplated by the plan did not admit of it—we hope that some one will do as good work for those features, and the popular life, too, of Egypt, as is done in this work for its politics and foreign relations. The material for illustrating them is abundant, and is lively, characteristic, human, and vastly fuller of interest than the long list of unpronounceable names of unknown kings, with their ascriptions of divine qualities to themselves, of which a chronicle of events must largely consist.

HISTORY AND PATHOLOGY OF VACCINATION. By EDGAR M. CROOKSHANK, M. B. Philadelphia: P. Blakiston, Son & Co. 2 vols.

THE story of the introduction of inoculation for the small-pox into England, and of its replacement by vaccination through the labors of Jenner, is fully told in these two fine volumes. It is a record which is extremely interesting and instructive to the lay reader, besides being historically valuable to the physician. The practitioner in England, where the work originated, will also find many of its facts and figures available for a practical purpose for which there is slight occasion in the United States, namely, for combating prejudice against vaccination. The first volume opens with a history of small-pox inoculation in various European and Asiatic countries and in England. Then follow the traditions, current among the dairy-maids in the last century, that persons who had taken the cow-pox from the animals were proof against the small-pox; and evidence is given to show that Benjamin Jesty, a farmer, purposely transferred the disease from a cow to his wife and his two children in 1774, thus anticipating Dr. Jenner in vaccination by over twenty years. A portrait of Jesty forms the frontispiece of the volume, and a small portrait of his wife is also given. An account of Jenner's life and his work in this field forms a large part of the volume, and contains extracts from many of his letters and essays on the subject. Successive chapters deal with various sources of vaccine lymph—namely, human small-pox, cattle-plague, sheep small-pox, goat-pox, cow-pox, and "grease" in horses. A brief account of the progress of vaccination in England after the death of Jenner is also given. The volume is illustrated with many full-page colored plates. The second volume consists of reprints of selected essays, beginning with the first edition of Jenner's Inquiry into the Causes and Effects of the *Variolæ Vaccinæ*, published in 1798. It contains also essays by Pearson, Woodville, Loy, Bousquet, Ceely, and other physicians prominent in the early history of vaccination, and several others by Jenner. The author contributes to this volume a paper describing an Outbreak of Cow-pox near Cricklade (Wiltshire) in 1887.

THE PSYCHOLOGY OF ATTENTION. By TH. RIBOT. Authorized Translation. Chicago: The Open Court Publishing Company. Pp. 121. Price, 75 cents.

THIS treatise is a clear and interesting study of the mechanism of the mental attitude that is necessary to any advance in skill or knowledge. It is founded upon the experiments and investigations of recent years, which have examined and defined the bodily manifestations accompanying the intellectual state. Heretofore many psychologists have been content to view attention from the subjective side only, and consequently have not given any comprehensible account of its genesis. M. Ribot uses the reverse method. He finds that there are two forms of attention: the primitive or natural, which he names spontaneous, exhibited by animals with only a few developed senses, and by man until training or force steps in; second, the artificial or voluntary, a cultivated product whose effects psychologists have dissected. Both forms are dependent upon emotional states, and the mechanism of each is motory, mainly in the form of inhibition or "arrested motion." The physical manifestations, the vaso-motor phenomena, the respiratory changes, the bodily expressions, and the cerebral effects, are the wheel-work of attention; and the patient investigation of these by Darwin, Riccardi, Galton, Maudsley, Preyer, and Féré, has made an explanation of its mechanism possible.

In considering the cerebral phenomena the old problem is encountered—whether

mind acts first upon body, or body upon mind. This M. Ribot declines to discuss. Voluntary attention originated after the earliest period of savagery, when man realized the alternative of perishing or going to work. It differs from the spontaneous form in that the motive or influence producing the emotional state is supplied from without. Educators make use of fear, sympathy, and curiosity, to cultivate attention in the child; as it advances in growth, duty, emulation, and ambition are introduced; and, finally, voluntary attention is maintained by habit and organization. A study of the internal mechanism shows that attention is accomplished by inhibition. In the normal state of consciousness, sensations, images, ideas come and go. Attention arrests this process and inhibits all but the chosen series. Energy is used to perpetuate this condition, and from this expenditure results the feeling of effort. The morbid cases of attention are treated under the heads Hypertrophy of Attention, Atrophy of Attention, and Congenital Infirmity. They prove that attention depends upon emotional excitation. Incidentally, M. Ribot gives some suggestive examples of what may depend upon full recognition of the physical nature of attention.

THE EXTERMINATION OF THE AMERICAN BISON. By WILLIAM T. HORNADAY. Washington: Government Printing-Office (Smithsonian Institution). Pp. 548, with Plates and Maps.

MR. HORNADAY is a naturalist and taxidermist by profession, and is superintendent of the National Zoölogical Park, thus combining qualifications which well fit him for making a book of this kind. He is, furthermore, a writer who knows how to interest the reader, and has composed an attractive as well as an instructive book. His purpose is to help the public fully to realize the folly of allowing all our most valuable and interesting American mammals to be wantonly destroyed, as the buffalo has been. The wild buffalo is practically gone forever; and it is doubtful whether the institution of preserves and the formation of herds, however intelligently they may be executed, will avail to save the species permanently, even in a captive state. In the first part of his work the author considers "the life-history of the bison," under the headings of Discovery of the Species, Geographical Distribution, Abundance, Character, Habits, Food, Mental Capacity and Disposition, Value to Mankind, and Economic Value to Western Cattle-Growers. The story of extermination is related in the second part. One of the most important chapters in the first part is that in which the value of the bison is estimated under domestication, in hybrids, and as a beast of burden. At present (May 1, 1889), "although the existence of a few widely scattered individuals enables us to say that the bison is not yet absolutely extinct in a wild state, there is no reason to hope that a single wild and unprotected individual will remain alive ten years hence. The nearer the species approaches to complete extermination, the more eagerly are the wretched fugitives pursued to the death wherever found." While the herds, which once ranged over nearly the whole of our country, formerly numbered hundreds of thousands of individuals, the few groups that are left count only dozens. An estimate made on the 1st of January, 1889, gave the whole number running wild—in all North America—as 635; and including those in captivity and those under Government protection in Yellowstone Park, the whole number of individuals of the species as 1,091; and these few are still hunted, and shot when found.

HANDBOOK OF PRACTICAL BOTANY. By E. STRASBURGER. Edited from the German by W. HILLHOUSE. Second edition, revised and enlarged. New York: Macmillan & Co. Pp. 425. Price, $2.50.

THIS volume embodies a course of laboratory work laid out by a botanist whom the English editor calls "one of the greatest living masters of microscopical observation." The introduction tells how to use the microscope, and describes the instruments of different makers. The first subject for study is the structure of starch of different kinds. A list of the material wanted is given at the head of the chapter; the appearance which each kind of starch should present under the microscope is described, its behavior under various reagents is noted, and directions for drawing the grains are given. The following lessons are similar in character. Among the subjects for investigation are movements of protoplasm, epidermis and stomata, the

structure of different kinds of stem, of cork, of the growing tip of stem and of root, the vegetative structure and the modes of reproduction of cryptogamous plants, and the structure of various seeds and fruits. The text is illustrated with 149 cuts. An appendix contains lists of plants and of reagents used in study, etc.

HANDBOOK OF COMMERCIAL GEOGRAPHY. By GEORGE G. CHISHOLM, Fellow of the Royal Geographical and Statistical Societies. London and New York: Longmans, Green & Co. Pp. 515. Price, $5.

COMMERCE has undergone a change of character in recent times the nature of which is indicated by the disappearance of the word "venture" from the commercial vocabulary. Cargoes of goods are not now shipped to distant ports in blind ignorance of whether or not a sufficient demand exists at their destination for the commodities sent. The legend of the rash Yankee, who apparently tempted the financial fates by sending a lot of warming-pans to the West Indies, would be impossible at this day. Commerce has settled down to a more even course, it is carried on by more exact methods, and is directed more by knowledge and less by chance than at earlier times. But there remains much room for improvement in the knowledge which importers and exporters possess of the products and the needs of foreign countries. To supply information of this sort, and in such a form that it may have "intellectual interest," is the aim of the present volume. "In writing the work," says the author, "I have had three classes chiefly in view: first, teachers who may wish to impart additional zest to their lessons in geography from the point of view of commerce; secondly, pupils in the higher schools and colleges that are now devoting increased attention to commercial education; and, thirdly, those entering on commercial life, who take a sufficiently intelligent interest in their business to make their private studies bear on their daily pursuits." An introductory chapter embodies certain general facts relating to the production, distribution, and exchange of commodities, such as differences in soil and climate, in the price and efficiency of labor, in facilities for transportation and communication, in import and export regulations, in language and money. The world's articles of commerce are then taken up, under a number of classes, and the source of supply of each, and, in case of the more important commodities, other details, such as mode of production, history of the industry, uses of the article, quality of the product from different places, and statistics of production. Then the countries of the world are taken up in succession, the location and geographical character of each is stated, its general commercial advantages and disadvantages are pointed out, after which the important products of the several sections and towns of the country are named, statistics being given in numerous instances. About thirty maps are interspersed through this part of the volume, showing the products, density of population, railways, etc., of different countries. An appendix of fifty pages gives tables of statistics in regard to the imports and exports of the chief countries of the world, and related information. The volume has a full index, which is far from a matter of course in English treatises.

THE BERMUDA ISLANDS. By ANGELO HEILPRIN. Philadelphia: The Author, Academy of Natural Sciences. Pp. 231. Price, $3.50.

THE material of this volume embraces geological, zoölogical, and botanical observations, and includes a few glimpses from the traveler's point of view. "My main object in visiting the islands," says the author, "was to satisfy my mind on certain points connected with the structure and physiognomy of coral reefs, to the study of which the Bermudas offer special advantages. I contemplated but little work in zoölogy, and that which was accomplished may be considered supplemental to the plan of work originally laid out." The first chapter, and to some extent the second, consist of "general impressions" of the islands and surrounding waters, and the inhabitants of both. The view herein given is less roseate but probably nearer correct than the descriptions of writers more dominated by poetic enthusiasm than by scientific accuracy. Prof. Heilprin next sketches the physical history and geology of the Bermuda Islands, and then takes up the coral-reef problem. He discusses the chief contributions that have been made to our knowledge of coral reefs, his own convictions being in favor of Dar-

win's subsidence theory. The following chapters deal with the zoölogy of the islands, consisting mainly of descriptions of the species collected. Prof. Heilprin states that "the Bermudian fauna is essentially a wind-drift and current-drift fauna, whose elements have been received in principal part from the United States and the West Indies," while certain mollusca and crustacea are of a distinctively Pacific type. An appendix, consisting of notes on the recent literature of coral reefs, is added. The volume is illustrated with seventeen full-page photo-engravings and lithographic plates.

LECTURES ON RUSSIAN LITERATURE. By IVAN PANIN. New York and London: G. P. Putnam's Sons. Pp. 220. Price, $1.50.

THE curious confession made in this volume that there is no originality in Russian literature, but that it acts as "a sieve for Western thought," or as "a wall against Asiatic barbarism," would seem to condemn it to the obscurity from which it has so lately emerged. The author believes, however, that the three virtues—intensity, moderation, and sincerity—which pre-eminently distinguish Russian poets and novelists, will not only rescue them from oblivion, but oblige Western writers finally to seek in them models of expression. He finds four phases of evolution in literature: First, the youthful period of joyous song; second, rebellion and lament; third, aggression and warfare; fourth, belief and inspiration. These are exemplified in Russia by Pushkin, the bard; Gogol, the protester; Turgenef, the warrior; and Tolstoi, the preacher. The Lectures are entertaining, and give the reader an insight into four typical Russian authors.

LESSONS IN THE STRUCTURE, LIFE, AND GROWTH OF PLANTS. By ALPHONSO WOOD. Revised and edited by OLIVER R. WILLIS. New York: A. S. Barnes & Co. Pp. 220. Price, $1.

THIS text-book was written more than twenty years ago, and is now recast and revised to adapt it to new means and methods of study, and to the advanced state of the science. In its new form it is offered as a suitable introduction and companion to any of the manuals of the flora of North America. Part I is devoted to structural, Part II to physiological, and Part III to systematic botany, but it is not prescribed that the subjects shall be taken up in this order. The volume is clearly printed and copiously illustrated, and is provided with a combined index and glossary.

A paper of nearly three hundred quarto pages on *The Geographical Distribution of Fossil Plants* has been prepared by *Lester F. Ward*, to form a part of the report of the United States Geological Survey for 1886–'87. It is a continuation of the Sketch of Paleobotany which appeared in the Fifth Annual Report, and will be followed by a paper on Problems of Paleobotany, in which the author will discuss many subjects in this field that he has not yet treated. The present paper takes the form of a narrative of the publication of discoveries of plant fossils. The division of the earth first taken up is Europe, and here the great number of small beds that have been discovered and of monographs that have been written about them precludes much more than a mention of each one. The flora of the arctic regions has been so magnificently treated by Prof. Oswald Heer that Mr. Ward has deemed it superfluous to pick up what little collateral matter has been brought out by other authors. Nearly the same statement applies to India, on account of Feistmantel's labors; and to Canada, where Dawson has done thorough work. But, in treating the United States, Mr. Ward has felt in duty bound to make the geographical review as complete as the data in his possession would permit. Here more analysis of the separate finds is made than in the case of the European countries. This section is accompanied by a map of the United States, on which the chief localities in which fossil plants of various geological ages have been found are indicated by different colored circles. Numerous foot-notes on every page give exact bibliographical information concerning the works referred to in the text. The paper has a full index.

The second number of the *Bulletin from the Laboratories of Natural History of the State University of Iowa* contains papers on the Anatomy of the Gorgonidæ, by C. C. Nutting—well illustrated; and on the Native Fishes of Iowa, by Seth E. Meek.

The *Report of the Council of the Cam-*

dian Institute depicts a year of progress during 1888–'89, and, according to the testimony of competent witnesses, shows that a wonderful amount of work was accomplished in proportion to the small sum of money which the society was able to command. Twenty-four ordinary meetings and thirty-six meetings of sections were held, at which seventy papers in all were read. The archæological report, by Mr. David Boyle, gives notices of several features of research and of the examination of a number of sites, and is accompanied by a paper on French relics from village sites of the Hurons, by Mr. A. F. Hunter, and a Bibliography of the Art and Archæology of the Dominion of Canada and Newfoundland, by Mr. A. F. Chamberlan.

The work of the *Geological and Natural History Survey of Minnesota* in 1888 was prosecuted by two parties, one of which, under Mr. Uly S. Grant, was occupied during a part of the season in making collections of rock samples in certain typical crystalline formations in typical localities, and afterward in the iron-ore beds; and the other, under Mr. Horace V. Winchell, spent the whole season on the iron-ore beds. The work added materially to the exact knowledge of the geology of the northeastern part of the State, and particularly to that of the nature and relations of the iron-ores. A general presentation of this knowledge, in a somewhat systematic manner, has been attempted in the report. The superintendent of the survey, Prof. N. H. Winchell, is about to enter on the preparation of a final report covering the northern part of the State.

Observations on Sexual Selection in Spiders of the Family Attidæ is a paper published in the "Occasional" Volume of the Natural History Society of Wisconsin, by *George W.* and *Elizabeth G. Peckham*. The investigation which it records is directed to the origin—in spiders—of color, and its relation to sexuality, concerning which two general theories are offered by Mr. Wallace: first, that natural selection modifies color in the female for purposes of protection; and, second, that color may be produced or intensified when there is a surplus of vital energy, as in male animals generally, and sometimes in the females, and more especially at the breeding season. Unusual facilities are offered for testing these theories by the Araneides on account of the great numbers of their species and the wide differences between the several groups in habits and in amount of ornamentation. The study of several genera shows that, in the sedentary groups of spiders, while many of the species are plainly colored, there are nearly as many that present the most beautiful tints; and some of the wandering and very active groups are, for the most part, clothed in somber hues. Again, no relation is shown between the color development of the females and their nesting habits. The former observation is contradictory to the supposition of a causal relation between vital activity and color development; the latter to that of the need of a protective coloring, while nesting, by the female. A further explanation of the sexual coloring is then sought, with the conclusion that some groups of spiders have reached a condition of close harmony with their environment; this harmony being brought about through the same modifications of color, form, and habit as are seen among insects, to the attainment of the common ends of capture of prey and protection from enemies.

In *Remarks upon Extinct Mammals of the United States*, Dr. R. W. Shufeldt publishes studies illustrated, of *Tinoceros ingens;* The Ancestry of the Horse; Ancient Whales and Coryphodons; Half-Apes and Lemurs; the Saber-Toothed Tigers, and Hairy Mammoths and Sea-Cows.

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POPULAR MISCELLANY.

Evolution of the Fish-Hook.—"The Evolution of the Fishing-Hook" has been made the subject of a study by Mr. Edward Lovett, who discerns the first implement of the kind in the flint "gorges," and some of the flints, which are called "knives," of the paleolithic "finds." They were fastened, perhaps, to a line of twisted vegetable fiber or to a thong of one of the whip-like seaweed algæ, by being suspended around the middle. When baited, the "hook" would move up and down. Swallowed by the fish and jerked up, it would be brought at right angles to the line and stand across the throat of the

fish, so as to bring it along. Another form was a bow, sharpened at both ends and tied around the middle; or a disk of haliotis-shell, which is still used, in connection with a hook, as a trolling bait for jack or pike. Some very early hooks appear to have been provided with some kind of a barb. Of the bone hooks of the Eskimos, one is mentioned that was carved to resemble a fish; another had an iron nail for a point; and another example had the shaft of bone, the point of iron, and a polished stone sinker, showing a combination of the Stone, Bone, and Iron ages in one specimen. The Fijians use a barbless hook of mother-of-pearl for trailing over the stern of a canoe, the glitter of which attracts the fish. Some hooks from the Ellis Islands are made of the iron wire in which European packing-cases are bound, which is bent into a curve, the end sharpened to a point, and turned inward and downward, and is lashed in such a way that the strain on the hook has a tendency to keep the curve in proper adjustment. One hook is made of a forked limb. In Europe, not many hooks are found anterior to the Iron age. Among the bronze hooks from the lake-dwellings of Switzerland is one very closely resembling the hooks of our own time. An extraordinary specimen is formed of the upper mandible of an eagle, notched down to the base. Hooks in the British Islands have undergone but little change, except in finish and quality, since the dawn of the Iron period. Looking upon the subject as a whole, we find a gradual development from the rudest form of stone, through shell, wood, bone, copper, and iron, down to the beautifully tempered fine steel salmon-hook of the present day; and we also have examples in which these stages of progression overlap one another, as shown by hooks of compound manufacture, like those of shell and bone, wood and bone, bone and iron, and even stone, bone, and iron together.

Cloud-bursts. — Many recent disastrous floods have owed their severity to a sudden down-pour of water occurring when the streams of the surrounding country were already filled by rain which had fallen previously. Such a down-pour is called a cloud-burst. As explained by Prof. Ferrel, in his book on The Winds, great quantities of rain and hail sometimes collect at a considerable height in the vortex of a tornado, being held up by the strong upward current of air. When the weight of the accumulated mass has become great enough to overcome the force of the ascending current, the rain or hail pours down at one or more points. The whole system may also become weak and break up from some other cause, when the same result follows. Thus, if a tornado heavily charged with rain, in moving over the country, strikes a mountain-side, its whirling motion is checked and the upward current weakened, when a cloud-burst results. This is why cloud-bursts occur oftenest on mountain-sides. It is not to be supposed that the accumulation of water would be evenly distributed over all parts of the ascending current, but it would collect at several points; hence, when it becomes able to force its way down, it descends not in drops, but in streams which often make great holes in the ground. On a steep mountain-side, if the stream continues for a short time only, it may give rise to a land-slide, or may wash out a great ravine, through which the water rushes down to the valley below, carrying rocks and trees along with it.

Treatment of Lightning-Shock.—A report of a curious case of lightning-shock, with recovery, has been published by Dr. J. B. Paige, of Montreal, with remarks by Drs. Frank Buller and T. Wesley Mills. The subject, a young married woman, was struck by a flash, the intensity of which was shown by its effects on metallic objects to be very great. It passed from a bird-cage, hanging near her, to her head above the left eye, thence along the ear to the central line of the thorax, along the stocking suspender to the top of the stocking, leaving marks on both legs. Thence no trace of the current was detected till the foot was reached, whence it passed, leaving large rents in the stocking and slipper, but no marks on the skin. The force of the shock was enough to throw the woman from the chair on which she was sitting, upon and across another some two or three feet distant. She was found completely unconscious, motionless, with muscles relaxed, left eye closed, right one open, face purple, pulse imperceptible, and neither heart-sounds nor respiratory murmur audi-

ble. Her clothes were loosened and artificial respiration was begun, and the first sign of life appeared about three minutes afterward. Breathing was greatly impeded, when respiration was first resumed, by accumulations of saliva, which were removed. Consciousness began to return and the muscles of the arm to regain strength in between half and three quarters of an hour. Sight was restored to the right eye, but it could not be moved. Though the subject could not speak, the paralysis passed away slowly, so that in about two weeks solid food could be swallowed. Twelve or fourteen hours after the accident, intense pain set in about the head, neck, arms, and chest, which did not pass away from the head for seven days, and occurred occasionally after that. At the end of four weeks the patient was able to return to her home. In six months complete recovery had taken place, except in the left eye. To the question whether the patient could have recovered without the assistance rendered just after the accident, Prof. Mills replies that "considering that respiration was suspended, that the circulation, even with artificial respiration, was so feeble that the temperature fell, that consciousness did not return for so long, it does not seem reasonable to believe in the possibility of spontaneous recovery. But the case does seem to teach, in the clearest way, the importance of using such means as those employed in this instance promptly and perseveringly."

Natural Guides to Land Values.—The chief of the Agricultural College at Downton, England, has given in a recently published article some of the indications by which the fertility of soils may be judged. The following colors indicate barrenness in soils: 1. Black, as being in most cases caused by an excess of vegetable matter or peat. 2. White, as indicating a thin, chalky soil, or the presence of white sand close to the surface. 3. Yellow, whether dark or light. 4. Light gray. 5. Blue. 6. A piebald or variegated color. A good soil ought to be from twelve to eighteen inches deep. Alluvial soils owe their fertility in a great measure to their depth. Tenacity does much to determine the productive power of soil. Tenacity is seen in the clearly cut furrow, and the impression left by the foot when the soil is moist. In tenacious soil the footprint is clear and sharp at the edges, and every nail-mark shows; whereas, in loamy soil the tread is indistinct and the edges of the footprint crumble away. In dry weather, a cracked surface and hard yellow clods are the marks of a stiff soil. The skillful judge of land will not rely too much upon the physical character of the soil alone. Land always covers itself with herbage of some sort, from the quality and quantity of which the best possible indication of the soil's yielding power may be obtained. Plenty of timber is a favorable augury. Who can not recall some beautiful valley where the well-grown trees seem almost to meet their branches over green meadows and patches of grain and other crops? On the other hand, inclement and thin soils carry a stunted and forlorn timbering. Turning to the sort of tree, we may mention large, spreading oaks as signs of good land. The elm is found to perfection on village greens and near to homesteads where the ground has become, or always was, rich, and in other favored situations. The mulberry and the walnut, the apple and the quince, are never found vigorous on other than good land; and the ash, the sycamore, and the chestnut are also indications of fertility. Certain other trees indicate the reverse. We see plantations of larch on barren uplands and soils difficult to put to other uses. Scotch fir, spruce, yew, and other cone-bearing trees are often found on poor land. Beeches thrive on the thinnest of limestone, and the birch will grow in the most unpromising places. Coming down to the plants, none is a more unfailing guide to fertility than chickweed. Nettles never grow on bad land, and dandelions and buttercups are not seen on poor pastures. Thistles also show a good soil. The state of growing crops and the appearance of stubbles should also be noted, although such indications may show rather the character of the farming. Certain wild grasses show barrenness, while grass-land which seems covered with dead, unkempt stuff, like badly made hay, is always barren.

Gardening Classes of the Missouri Botanical Garden.—The Trustees of the Missouri Botanical Garden, carrying on the in-

tentions of Mr. Shaw, its founder, have prepared a plan of garden scholarships, providing for the instruction of a limited number of pupils in practical horticulture. The classes are intended to consist of six pupils, who will be taught for not more than six years each. They will be regarded as apprentices in the Botanical Garden, and required to work in it under the direction of the head gardener, performing the duties of garden hands, and being advanced gradually from simpler to more responsible tasks. After the first year their working hours will be reduced to five a day, that they may devote the rest of the time to study, in which they will enjoy free the privileges of the tuition of the School of Botany at Washington University. For their services in the garden they will be paid from two hundred to three hundred dollars a year, with conveniently situated lodgings. Applicants for scholarships will be examined in the upper grammar-school branches; and, in case of an excess of them, will be subjected to competitive examination, in which other branches will be brought in. The studies will be, for the first year, in practical duties; for the second year, vegetable and flower gardening, small-fruit culture, and orchard culture; for the third year, readings in forestry, elementary botany, landscape gardening, and the rudiments of surveying and draining; for the fourth year, botany of weeds, garden vegetables, and fruits; for the fifth year, vegetable physiology, economic entomology, and fungi; for the sixth year, botany of garden and greenhouse plants, ferns, and trees in their winter condition, with the theoretical part of some branch of special gardening. Pupils will also be trained in legal forms and in keeping accounts. Two of the six scholarships are at the disposal of local horticultural societies, provided their candidates pass the examinations.

Museum of the University of Pennsylvania.—The Archæological Museum of the University of Pennsylvania, begun in December, 1889, by the purchase of a small collection of stone implements, has grown in the few months since, till it includes ten thousand objects from all the United States, Mexico, Central America, and parts of South America. It is intended to make it representative of the early civilization of the Americas, and to exhibit as far as possible the implements used by the Indians, in their warfare, agriculture, and domestic life, before the advent of Columbus. It is intended hereafter to build up the collection mainly by explorations, and to this end all parts of the country will be thoroughly searched. In addition to the American specimens, the museum contains a fine collection of flints, bronze implements, and pottery from Europe, and objects from Asia, Africa, and the South Sea islands. Preparations are making by Prof. Rothrock for the establishment in the university of a Museum of Economic Botany, to consist of all kinds of woods, vegetable fibers, grains, and drugs, arranged so as to illustrate the processes of manufacture from the raw product, and the various uses to which each material may be put. It is expected to make this department of practical use to manufacturers and wood-workers, who may be guided by its aid to the selection of suitable material, and learn where it can be got.

Coffin-Nails.—Baring-Gould has contributed to The Gentleman's Magazine an article full of curious lore on this sepulchral subject. He says that the studding of a coffin with nails—which has evidently not ceased to be common in England—is a curious survival. The nails are no longer of any use, for the lid is fastened down with screws, but even when stone coffins were used — sarcophagi—the nails were not omitted. Iron was from the first regarded with superstitious reverence. In Egypt iron was the symbol of victory over death—of the power of resurrection given to man. The Romans also had a reverence for iron, and attributed to it mysterious powers. By drawing a circle on the ground or in the air, with an iron point, thrice round a person, they believed all noxious influences were banished. An iron spike applied lightly to a wounded part would relieve its pain. Rust for curative and protective purposes might be had from old nails, from which it must be removed with moistened iron. The nail was specially used because it was a symbol of fate. On the Ides of September every year the highest in authority in Rome drove a nail into the wall of the Temple of Jupiter. That day was the

beginning of the Roman year, and the driving of the nail was thought to bring with it prosperity for the new year. Livy tells us that when the gods seemed hostile and unmoved by the distresses of the nation, the dictator broke the spell of evil by driving in a nail. Once a nail driven in had banished a plague; then a nail had healed discord. Pliny says that, if a nail be driven into the pillow on which a man suffering from epilepsy has laid his head, it will heal him. In all these notices we see iron used as destroying the power of evil, breaking the force of disaster, banishing disease, expelling death. Consequently, nails were put in urns or funereal cists to keep away from them every evil power, demons, witches, and as a pledge of final restoration. The iron horseshoe nailed to a door owes its power to break the force of witchcraft not only to its being a symbol of Odin's horse, but also to the metal of which it is composed. Shears were frequently buried with bodies down till late in the middle ages. It is said that even within the memory of man they have been buried in coffins with corpses in Swabia. Sometimes as many as five were laid in the coffin with one corpse. The idea was the same as with nails—the metal was the important matter, rather than the form it took. The steel or iron was a preservative to the corpse, a protection and an assurance of resurrection. For the same reason that nails and shears were buried with the dead, swords were laid with them, and not necessarily because they would need them in the next world. Even Charlemagne was buried with his sword. The Icelandic sagas are full of stories of cairns broken into by heroes to rob the dead of their swords. Already in historic times the significance of the sword buried with the dead was lost; and in the Saga of Olaf the Saint a ghost actually invites a Norseman to break into his tomb and relieve him of his sword and other valuables.

Habits of the Manatee.—The London Zoölogical Society has acquired a living specimen of the manatee, one of the only two kinds of "herbivorous cetaceans" now existing. Concerning the habits of these animals, Miss Agnes Crane has written, from observations of a pair several years ago in the Brighton Aquarium, that lettuce and endives, of which they could eat thirty pounds a day, formed their favorite food. The male would devour at a pinch leaves of the cabbage, turnip, and carrot. Both relished those of the dandelion and sow-thistle. Sometimes the animals would swim about and pursue the leaves floating on the water; at other times the plants were seized in their mouths, drawn down, and eaten under the water, while the hand-like fore-fins were employed in separating the leaves. The food was invariably swallowed below the surface. They are not at all at ease when out of the water, but seem oppressed by their bulk. The male was observed to make a few attempts at terrestrial progress by turning himself round and moving a few inches when the tank was empty. With jaws and tail-fin pressed closely to the ground, the body of the animal became arched, and was moved by a violent lateral effort, aided and slightly supported by the fore-paddles, which were stretched out in a line with the mouth. But the effect of these very labored efforts was not commensurate with their violence; and their relation to active locomotion might be compared to the state of a man lying prone, with fettered feet and elbows tied to his side.

Odd Dishes of the Olden Time.—The cook-books of a hundred or more years ago afford reading well adapted to excite curiosity of appetite, if we may speak in that way. Their lists of pickles and flavors embraced a great many articles that we do not think now of using in that way. Jams were made of vegetables; parsnips, raspberries, etc., were made into cakes; and beets, potatoes, and oranges into biscuits. For making violet cakes the directions were to "take the finest violets you can get, pick off the leaves, beat the violets fine in a mortar with the juice of a lemon, beat and sift twice their weight of double-refined sugar, put your sugar and violets into a silver saucepan or tankard, set it over a slow fire, keep stirring it gently until all your sugar is dissolved; if you let it boil it will discolor your violets; drop them in china plates; when you take them off put them in a box, with paper between every layer." Wines were made of every fruit; of such flowers and vegetables as cowslips and parsnips;

from flowers and berries of elder; from sycamore, walnut, blackberry, and balm. To make shrub, to one gallon of milk flavored with lemons and Seville oranges were added two quarts of red wine, two gallons of rum, and one gallon of brandy. The books give directions how to spin gold and silver webs for dessert, to spin birds' nests, to make a Chinese temple or obelisk, a fish-pond with silver and gold fishes, a hen's nest with strips of lemon for straw, and eggs filled with flummery, and a hen and chickens in jelly. To make a "desert island," "take a lump of paste and form it into a rock three inches broad at the top, set in the middle of a deep china dish, and set a cast figure on it with a crown on its head and a knot of sugar-candy at its feet, etc. . . . If this dish is for a wedding supper, put two figures instead of one." There are also recipes for a "rocky island," a "floating island," with sheep and swans, "or you may put in snakes or any wild animals of the same sort," "Solomon's temple in flummery," "moonshine," and "moon and stars in jelly"—a half-moon with seven stars shining out of flummery colored with cochineal and chocolate to imitate the color of the sky. Among solid dishes the books tell how to make porcupine of a breast of veal, to surprise a shoulder of mutton or any other joint, to dress a joint to look like a hen and chickens, to bombard veal, to transmogrify pigeons, to Florentine a hare, make a Solomon Gundy, make an artificial turtle, and barbecue a pig.

Trees and Malaria.—According to Prof. Corrado Tommasi Crudelli, some of the prevalent notions respecting relations of forests and malaria are mistaken ones. The relations are not direct. Forests do not contribute to the propagation of malaria unless they are growing upon a malarious soil; and they can not make a soil malarious which would not be malarious without them. But they favor the development of malaria, when it is already there, by intercepting the solar rays, and thus checking evaporation and retaining moisture in summer. When the obstacle to the direct action of the solar rays is removed from infected land, the summer drying lessens the malarious generation, and in some favorable circumstances may even arrest it. The idea prevails in Rome that forests act as a screen to prevent malaria from crossing them by causing it to be filtered out in their foliage, and the establishment of forests at certain places is advised for that purpose. But it has been proved that the destruction of woods and forests in such situations has not led to an increase of malaria, but frequently to its mitigation by promoting better drainage and improved cultivation. The production of fevers in the *Agro Romano* and in Rome is the result of a complexity of meteorological and physiological conditions. An abundant development of malaria is verified only when the malarious soil is damp and warm. The malarious charge of the atmosphere may vary greatly according to the different proportion of the two indispensable factors of malaria—heat and moisture. If both are at their maximum, so is the malaria, especially when the sky is clear. When the malarious charge of the atmosphere has been great for many days in succession, and the bodies of the inhabitants have become more or less impregnated with the malarious germs, a fall of temperature may be very injurious, by causing an arrest of the germs within the organism and preventing their rapid elimination by the secretions. Hence it is that northern winds exercise an unfavorable influence during the fever seasons.

Soda Salts in Arizona.—The deposits of sulphate of soda of the valley of the Verde River, Arizona, have long been known and extensively quarried by the *rancheros* of the region to obtain a substitute for salt for cattle and horses. They have recently been visited by William P. Blake, who found the deposits of thenardite and allied minerals associated with it to cover several acres in extent, and reach a thickness of fifty or sixty feet or more. They appear as a series of rounded hills, with sides covered with a snow-white efflorescence and a greenish-colored and yellow clay at the bottom and top, partially covering the saline beds. The bulk of the deposits consists of thenardite, in a coarsely crystalline mass, so compact and firm that it has to be got out by drilling and blasting. The white efflorescence on the hills is composed of the hydrous sulphate of soda (*mirabilite*), which occurs in close association with the thenardite. Other asso-

ciated minerals are rock-salt in beautifully transparent masses, sparingly disseminated; the anhydrous sulphate of lime and soda (*glauberite*); and "pseudomorphs," in which the glauberite having disappeared, its place is supplied by amorphous carbonate of lime exactly filling the matrices of its crystals.

Holy Things and Toys from Torres Strait.—Prof. A. C. Haddon has fitted up in the British Museum a collection of objects from Torres Strait, which illustrates the customs and superstitions of the people of that still savage quarter. Among the objects are some forty native skulls, some of which had been strung in bunches as trophy decorations of the hut of a warrior, while others had been used for ceremonies and divination. The great eccentric masks employed in semi-religious and secular dances are represented by specimens which the collector believes to be the last of their kind. One of them, a crocodile mask, had such striking powers that the native from whom it was obtained refused to put it on for fear that death would be the consequence, because it was not the season of the year when it might be legitimately worn. Of the charms, those in stone and wood shaped like dugongs are very interesting. There are charms to protect against poisoning, love-charms, rain-making charms, charms to make the tobacco-plant grow; female figures, some in coral to keep the fire in when the housewife is absent; and taboo figures and signs of various kinds. The musical instruments include some ingenious drums, "bull-roarers," and a new kind of simple construction. Of toys there are tops of considerable weight, of which the Papuan spins several on his toes at the same time, and arrangements of string used as a sort of cat's cradle. The implements and articles of clothing and those for personal adornment are varied. An ornament worn by a betrothed girl appears to be derived from two fish-hooks placed back to back. Several specimens grimly illustrate the old savage customs. A hard-wood weapon is marked with eleven notches, to indicate as many heads which the owner has cut off. A double cassowary head-dress that belonged to a late king of the island Tud was handed over by his son to Prof. Haddon, together with the boar-tusks which he wore in his mouth on war expeditions, on the understanding that they were to go to the British Museum, where "plenty men" wanted to see them. When drawings or photographs of some of the natives were being taken they would ask, "Queen Victoria, he see picture along we fellow?"—that is, Will Queen Victoria see our picture?—to which the professor replied in the same strain, "S'pose he want, he see; I no savee. Plenty men along England want to savee about you fellow." Some of these photographs may now be seen in this collection, recording features and decorations which, in a few years, will have died out.

NOTES.

Dr. S. Weir Mitchell, of Philadelphia, recently received from a woman-patient the singular present of a cord of white-oak wood, chopped down and sawed up by her own hands. He had recommended to her an active, outdoor life in the woods for nervous invalidism. She had followed his directions, with results of which the cord of sawed wood was one of the evidences.

Dr. E. N. Sneath, lecturer on the History of Philosophy at Yale, has been inspiring the preparation of a series of small volumes of selections from the leading philosophers from Descartes down, so arranged as to present an outline of their systems. Each volume will contain a biographical sketch of the author, a statement of the historical position of the system, and a bibliography. Those so far arranged for are Descartes, by Prof. Ladd, of Yale; Spinoza, by Prof. Fullerton, of the University of Pennsylvania; Locke, by Prof. Russell, of Williams; Berkeley, by ex-President Porter, of Yale; Hume, by Dr. Sneath, of Yale; and Hegel, by Prof. Royce, of Harvard. Kant, Comte, and Spencer will certainly be added to the series, and others if encouragement is received. The publishers will be Henry Holt & Co.

The American Academy of Political and Social Science, of which Prof. Edmund J. James is president, was founded in December, 1889, for promoting the study of the political and social sciences, particularly of those which are omitted from the programmes of other societies, or which do not at present receive the attention they deserve. Among them are sociology, comparative constitutional and administrative law, philosophy of the state, and portions of the field of politics. It will attend to the publication of material that will be of use to students which does not now reach the public in any systematic way. The plan of the academy includes meetings for the presentation of papers and

communications, the establishment of a library, and the dissemination of knowledge through publications and by other means.

THE Messrs. Merriam, publishers of Webster's Dictionary, issue a circular calling attention to the misleading way in which a cheap reprint of an old edition of Webster's Unabridged Dictionary is being advertised. It is the edition of 1847, the copyright of which has expired by the lapse of forty-two years. It lacks all the words that have been added to the language since 1847, and these, especially in the department of science, have been many; it contains numerous etymologies that have been proved erroneous by the results of later research; it lacks the tables of biographical, geographical, and other information, which are appended to recent editions of Webster, and it has no illustrations in the body of the volume. The reprint is produced by some method of photogravure, giving blurred letters, very trying to the eyes, and the paper and binding are so flimsy that the book must fall to pieces with very little use. It is not the current edition of Webster's Unabridged Dictionary, as its publishers wish the public to believe—it is not even the "original" edition, as it explicitly claims to be, for that was published in 1828.

THE most interesting feature of Dr. R. W. Shufeldt's report to the American Ornithologists' Union on Progress in Avian Anatomy for the Years 1888-1889, is the announcement that a Handbook to the Muscles of Birds has been prepared by the author, and is in the press of Macmillan & Co. It is based on studies of the raven. Several monographs, mostly technical, by Dr. Shufeldt and other authors, American and foreign, are mentioned in the report. Among them is one by Mr. F. A. Lucas, on the Skeleton of the Extinct Great Auk.

A CLEAR and forcible article on The Suppression of Consumption, by G. W. Hambleton, is published in Science for April 25th. Dr. Hambleton deems the most important step in suppressing this disease to be to reduce its production. The means which he recommends for this end are almost entirely hygienic, and are based on the theory that consumption is produced by conditions that impede the respiratory functions. The chief of these are compression of the chest, and the presence of dust in the air inhaled. His statements are well fortified by cases which he has treated successfully, including his own.

THE first fossil found in the "Cheyenne sandstone" of Kansas—which is considered referable to the Trinity division of Arkansas and Texas—is described by Mr. F. W. Cragin as a part of a cycad, similar to those from the Purbeck Dirt-beds of England, but differing from them in form and in the size of the petioles. A leaf of *Platanus*, found in a stratum of very fine, soft chalk of supposed Niobrara Cretaceous age, is described by the same author as of interest, both on account of its preservation in a kind of rock in which land vegetation is rare, and because it contributes evidence that chalk is sometimes formed very near land, and if so, then presumably in water of but moderate depth.

THE increase of leprosy in British Guiana is attracting attention. It was introduced by negroes from Africa, and added to by immigrants from India in 1842 and 1858, and from China in 1861 and 1862. One Indian tribe was infected with it fifty years ago from the negro colony, but no other tribe has had it. Mr. J. D. Hilles, of Demerara, who has investigated the subject, is convinced that the disease is communicable by marriage or cohabitation, and by inoculation or contact. He has seen cases that undoubtedly arose by contagion.

THE investigations of Dr. Th. Kocher, of Berne, on goitre, while they do not clear up the question of the origin of the disease, cast a dim light upon it. Comparing the water of the parts of his canton in which goitre is common with those parts that are free from it, the author found considerable quantities of organic or organized material in it. In certain goitrous parts, particular families having access to special water-supplies free, or relatively so, from this organic material are free from goitre, although breathing the same air, living on the same soil, engaging in the same occupations, and eating the same food with their goitrous neighbors. Hence, he concludes, the organic factor is the one that determines the prevalence of goitre.

MR. JOSEPH THOMSON commends the semi-civilized region forming the central area of the Niger basin as one of the most promising fields for commerce in all tropical Africa. It is densely populated, and is divided into powerful and, for Africa, well-governed empires, in which life and property are fairly secure. The people have made some advance in civilization, and are famed for the excellence of their manufactures. Inland trade is organized, an efficient transport service exists, labor is abundant, the Niger presents an uninterrupted water-way to the very heart of the region, and the country is healthy, for Africa.

A LARGE stump of *Syringodendron alternans*, discovered some time ago standing in the coal mines of St. Etienne, France, is about ten feet high, three feet in diameter at the starting-point of the roots, and twenty inches in diameter at the top. The roots resemble the fossil *Stigmaria*. The trunk has the cicatrices and flutings of the *Sigillaria*, and the leaves seem to have been linear. In a prostrate tree (upper part) of the same species a few feet from this one, the leaf-scars were more clearly marked, but smaller.

Dr. E. Paget Thurston believes that while it is theoretically right to omit farinaceous food in feeding infants that have to be brought up by hand, a little is needed when cow's milk is used, to retard curdling. These solids, as well as the preparations of barley, isinglass, and linseed, act mechanically by adding something to thicken the milk, and entangle the curds as they are formed. In the shape of bread-crust, Brighton biscuit, or other "infant's foods," they may be added in very small quantities, so that the milk can still be sucked through the tube of a feeding-bottle.

Cases of lead-poisoning among the Jacquard weavers in a Swiss factory were traced by F. Schüler to the dust from leaden weights which are used by the weavers to carry the thread of their warp. After the varnish has been rubbed off from the weights, the lead begins to wear away, and falls in fine particles among the dust on the floor. In some cases this dust is as much as 56·86 per cent lead, and even when the utmost care was taken, nine or ten per cent of lead was found in it.

According to Mr. Hansen-Blansted, the beech is overcoming all other trees in the struggle for existence in the Danish forests. It is driving out the birch, except in marshy places; it is taking the place of the firs; and there are signs that it is gradually gaining the advantage over the oaks.

OBITUARY NOTES.

Sir Robert Kane, a distinguished Irish chemist and author, died in Dublin, February 16th. He was born in Dublin in September, 1810. His father was the proprietor of sulphuric-acid and alkali works near the city, and he developed a taste for chemical knowledge very early in life, publishing his first paper—On the Existence of Chlorine in the Native Peroxide of Manganese—in 1828. This was followed by other contributions. He was appointed Professor of Natural Philosophy to the Dublin Society in 1834, and devoted himself to original research in chemistry. He was afterward head of the Museum of Irish Industry, and first President of Queen's College, Cork. He was author of a large and important work on the Industrial Resources of Ireland. He received many honors, in recognition of his scientific labors, from the Government and from learned societies.

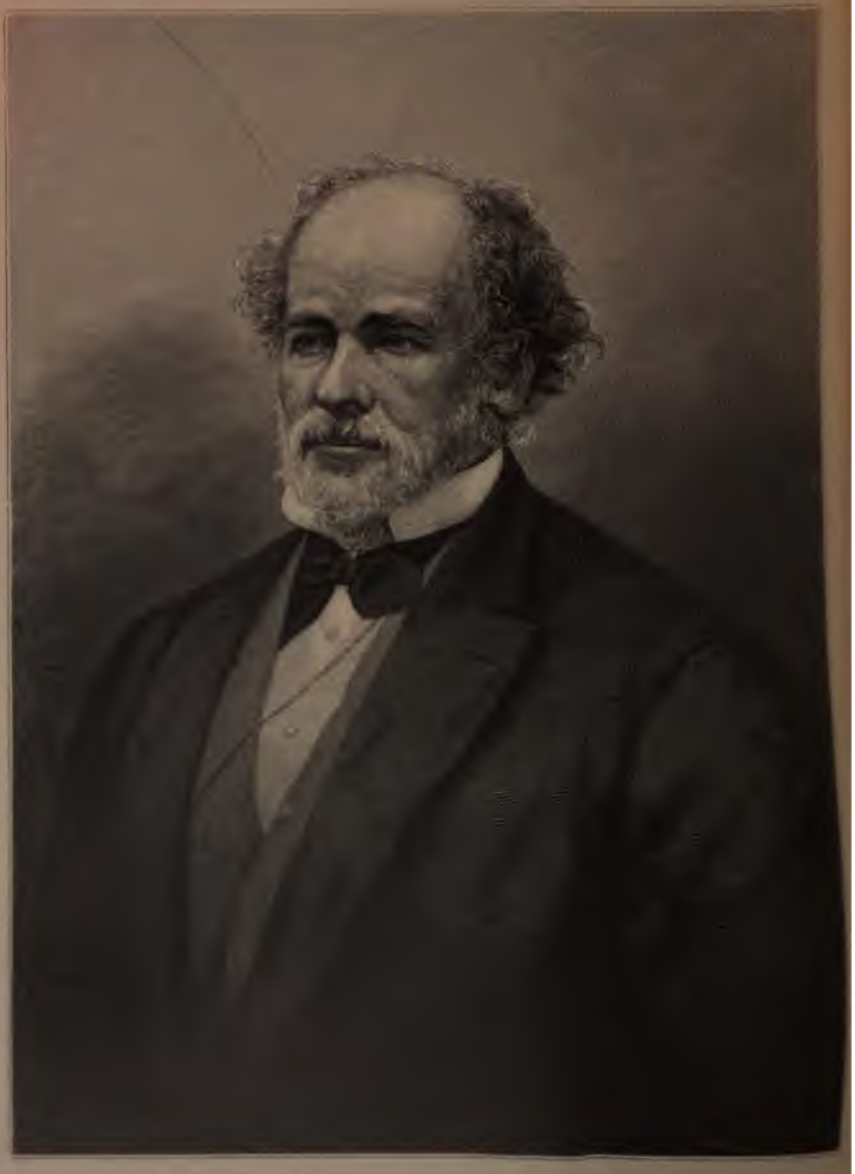
M. Edmond Hébert, an eminent French geologist, died April 4th, in the seventy-eighth year of his age. He was made Professor of Geology at the Sorbonne in 1857, and in the same year was chosen to succeed Charles Sainte-Claire Deville in the Section of Mineralogy in the Academy of Sciences. He was author of many important geological memoirs. His principal works were on the Oscillations of the Crust of the Earth, and the Ancient Seas and their Shores in the Paris Basin. He was an exponent of the doctrine of the adequacy of existing causes to explain geological phenomena.

Prof. von Quenstedt, of Tübingen, one of the most famous of German paleontologists, and a mineralogist, too, died December 21st. He was author of works on the Jura, and one on petrifactions or fossils. He was distinguished for his profound knowledge of the Lias of Würtemberg and its fossils.

Dr. Paul Niemeyer, Sanitary Counselor, and author of works relating to hygiene, died in Berlin, on the 25th of February, in the fifty-sixth year of his age. Several of his books, including his Doctrine of Health, Advice to Mothers, and Sunday Rest, had wide circulation, and were translated into other languages. He assisted Miss Nightingale in the revision of her Notes on Nursing.

M. Charles M. V. Montigny, a Belgian astronomer and meteorologist, died near Brussels, March 16th, aged about seventy years. He was honorary professor in the Royal Athenæum of Brussels, and a member of the Belgian Academy of Science; and had been connected with the observatory as a correspondent since 1879. His most important researches were on the scintillation of the stars, for which he invented an instrument called the scintillometer, which he observed industriously for several years, and which led him to new views concerning refraction; the relation of the height of the barometrical column and the pressure of the wind; the velocity of the wind, and its inclination. In the last research he is believed to have been the first who occupied himself with the subject.

Dr. George Thurber, an eminent botanist and writer on horticultural subjects, died in Passaic, N. J., April 2d, in the seventieth year of his age. He was born in Providence, R. I., in 1821. Studying pharmacy, he became interested in botany. In 1850, in connection with the United States and Mexico Boundary Survey, he explored the botany of the country between the Gulf of Mexico and the Pacific Ocean. The results of this study were published by Asa Gray in Plantæ Novæ Thurberianæ. He was from 1859 to 1863 Professor of Botany and Horticulture in the Agricultural College of Michigan. As editor of the American Agriculturist, from 1863 till 1885, he made it the ablest and most influential journal of its class. He published, in 1859, American Weeds and Useful Plants—an enlargement of Darlington's Agricultural Botany; contributed on botanical subjects to Appletons' Cyclopædia; and made a thorough, systematic study of grasses.



MATTHEW FONTAINE MAURY.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

IX. THE ANTIQUITY OF MAN AND PREHISTORIC ARCHÆOLOGY.

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WHILE the view of chronology based upon the literal acceptance of Scripture texts was thus shaken by researches in Egypt, another line of observation and thought was slowly developed, even more fatal to the theological view.

From a very early period there had been dug from the earth, in various parts of the world, strangely shaped masses of stone, some rudely chipped, some polished; in ancient times these were generally considered as thunderbolts, and known as "thunder-stones." This idea was carried into the middle ages, and we find in the eleventh century an emperor of the East sending to the Emperor Henry IV, of Germany, a "heaven axe"; and, in the twelfth century, a Bishop of Rennes asserting the value of thunder-stones as a divinely appointed means of securing success in battle, safety on the sea, security against thunder, and immunity from unpleasant dreams: even as late as the seventeenth century a French ambassador brought a stone hatchet, which still exists in the museum at Nancy, as a present to the Prince-Bishop of Verdun, and claimed for it health-giving virtues.

Yet, as early as the latter part of the sixteenth century, Michael Mercati tried to prove that the "thunder-stones" were weapons or implements of early races of men, though from some cause his book was not published until the following century, when other thinking men had begun to take up the same idea.

But early in the eighteenth century a fact of great importance was quietly established: in the year 1715 a large pointed weapon of black flint was found in contact with the bones of an elephant,

in a gravel-bed near Gray's Inn Lane, in London. The world in general paid no heed to this; if the attention of theologians was called to it, they dismissed it summarily with a reference to the Deluge of Noah; but the specimen was labeled, the circumstances regarding it were recorded, and both specimen and record carefully preserved.

In 1723 Jussieu addressed the French Academy on The Origin and Uses of Thunder-stones. He showed that recent travelers from various parts of the world had brought a number of weapons and other implements of stone to France, and that they were essentially similar to what in Europe had been known as "thunder-stones": a year later this fact was clinched into the scientific mind of France by the Jesuit Lafitau, who published a work showing the similarity between the customs of aborigines then existing in other lands and those of the early inhabitants of Europe. So began, in these works of Jussieu and Lafitau, the science of comparative ethnography.

In 1730 Mahudel presented a paper to the French Academy of Inscriptions on the so-called "thunder-stones," and also presented a series of plates which showed that these were stone implements, which must have been used at an early period in human history.

In 1778 Buffon, in his Époques de la Nature, intimated his belief that "thunder-stones" were made by early races of men; but he did not press this view, and the reason for his reserve was obvious enough: he had already one quarrel with the theologians on his hands, which had cost him dear—public retraction and humiliation; his declaration, therefore, attracted little notice.

In the year 1800 another fact came into the minds of thinking men in England. In that year John Frere presented to the London Society of Antiquaries sundry flint implements found in the clay-beds near Hoxne; that they were of human make was certain, and, in view of the undisturbed depths in which they were found, the theory was suggested that the men who made them must have lived at a very ancient geological epoch; yet even this discovery and theory passed like a troublesome dream, and soon seemed to be forgotten.

About twenty years later Dr. Buckland published a discussion of the subject, in the light of various discoveries in the drift and in caves. It received wide attention, but theology was hushed to silence by his soothing concession that these striking relics of human handiwork, associated with the remains of various extinct animals, were proofs of the Deluge of Noah.

In 1823 Boué, of the Vienna Academy of Sciences, showed to Cuvier sundry human bones found deep in the alluvial deposits of the upper Rhine, and suggested that they were of an early geological period; this Cuvier virtually, if not explicitly, denied:

great as he was in his own field, he was not a great geologist; he, in fact, led geology astray for many years. Moreover, he lived in a time of reaction; it was the period of the restored Bourbons—of the Voltairean King Louis XVIII, governing to please orthodoxy. Boué's discovery was, therefore, at first opposed, then enveloped in studied silence.

Cuvier evidently thought, as Voltaire had felt under similar circumstances, that "among wolves one must howl a little"; and his leading disciple, Élie de Beaumont, who succeeded him in the sway over geological science in France, was even more opposed to the new view than his great master had been. Boué's discoveries were, accordingly, apparently laid to rest forever.*

In 1825 Kent's Cavern, near Torquay, was explored by the Rev. Mr. McEnery, a Roman Catholic clergyman, who seems to have been completely overawed by orthodox opinion in England and elsewhere; for, though he found human bones and implements mingled with remains of extinct animals, he kept his notes in manuscript, and they were only brought to light more than thirty years later by Mr. Vivian.

The coming of Charles X, the last of the French Bourbons, to the throne, made the orthodox pressure even greater. It was the culmination of the reactionary period—the time in France when a clerical committee, sitting at the Tuileries, took such measures as were necessary to hold in check all science that was not perfectly "safe"; the time in Austria when Kaiser Franz made his famous declaration to sundry professors, that what he wanted of them was simply to train obedient subjects, and that those who did not make this their purpose would be dismissed; the time in Germany when Nicholas of Russia and the princelings and ministers under his control, from the King of Prussia downward, put forth all their might in behalf of "scriptural science"; the time in Italy when a scientific investigator, arriving at any conclusion distrusted by the Church, was sure of losing his place and in danger of losing his liberty; the time in England when what little science was taught was held in due submission to Archdeacon Paley's doctrines and the Thirty-nine Articles; the time in the United States when the first thing essential in science was, that it be adjusted to the ideas of revival preachers.

Yet men devoted to scientific truth labored on; and in 1828

* For the general history of early views regarding stone implements, see the first chapters in Cartailhac, La France Préhistorique; also Joly, L'Homme avant les Métaux; also Lyell, Labbock, and Evans. For lightning-stones in China, see citation from a Chinese encyclopædia of 1662, in Tylor, Early History of Mankind, p. 209. On the universality of this belief on the surviving use of stone implements even into civilized times, and on their manufacture to-day, see ibid., chapter viii. For the treatment of Boué's discovery, see especially Mortillet, Le Préhistorique, Paris, 1885, p. 11.

Tournal, of Narbonne, discovered in the cavern of Bize specimens of human industry, with a fragment of a human skeleton, among bones of extinct animals. In the following year Christol published accounts of his excavations in the caverns of Gard; he had found in position, and under conditions which forbade the idea of after-disturbance, human remains mixed with bones of the extinct hyena of the early Quaternary period. Little general notice was taken of this, for the reactionary orthodox atmosphere involved such discoveries in darkness.

But in the French Revolution of 1830 the old politico-theological system collapsed: Charles X and his advisers fled for their lives; the other continental monarchs got glimpses of new light; the priesthood in charge of education were put on their good behavior for a time, and a better era began.

Under the constitutional monarchy of the house of Orleans in France and Belgium less attention was therefore paid by Government to the saving of souls; and we have in rapid succession new discoveries of remains of human industry, and even of human skeletons so mingled with bones of extinct animals as to give additional proofs that the origin of man was at a period vastly earlier than any which theologians had dreamed of.

A few years later the reactionary clerical influence against science in this field rallied again. Schmerling in 1833 explored a multitude of caverns in Belgium, especially at Engis and Engihoul, and found human skulls and bones closely associated with bones of extinct animals, such as the cave bear, hyena, elephant, and rhinoceros, while mingled with these were evidences of human workmanship in the shape of chipped flint implements; discoveries of a similar sort were made by De Serres in France and Lund in Brazil; but, at least as far as continental Europe was concerned, these discoveries were received with much coolness, both by Catholic leaders of opinion in France and Belgium, and by Protestant leaders in England and Holland. Schmerling himself appears to have been overawed, and gave forth a sort of apologetic theory, half scientific, half theologic, vainly hoping to satisfy the clerical side.

Nor was it much better in England. Sir Charles Lyell, so devoted a servant of prehistoric research thirty years later, was still holding out against it on the scientific side; and, as to the theological side, it was the period when that great churchman, Dean Cockburn, was insulting geologists from the pulpit of York Minster, and the Rev. Mellor Brown denouncing geology as "a black art," "a forbidden province"; and when in America Prof. Moses Stuart and others like him were belittling the work of Benjamin Silliman and Edward Hitchcock.

In 1840 Godwin Austin presented to the Royal Geological So-

ciety an account of his discoveries in Kent's Cavern near Torquay, and especially of human bones and implements mingled with bones of the elephant, rhinoceros, cave bear, hyena, and other extinct animals; yet this memoir, like that of McEnery fifteen years before, found an atmosphere so unfavorable that it was not published.

But just at the middle of the nineteenth century came the beginning of a new epoch in science—an epoch when all these earlier discoveries were to be interpreted by means of investigations in a different field: for, in 1847, a man previously unknown to the world at large, Boucher de Perthes, published at Paris the first volume of his work on Celtic and Antediluvian Antiquities, and in this he showed engravings of typical flint implements and weapons, of which he had discovered thousands upon thousands in the high drift beds near Abbeville in northern France.

The significance of this discovery was great indeed—far greater than Boucher himself at first supposed. The very title of his book showed that he at first regarded these implements and weapons as having belonged to men overwhelmed at the Deluge of Noah; but it was soon seen that they were something very different from proofs of the literal exactness of Genesis: for they were found in terraces at great heights above the river Somme, and, under any possible theory having regard to the truth, must have been deposited there at a time when the river system of northern France was vastly different from anything known in the historic period. The whole discovery indicated a series of great geological changes since the time when these implements were made, requiring cycles of time compared to which the space allowed by the orthodox chronologists were as nothing.

His work was the result of over ten years of research and thought. Year after year a force of men under his direction had dug into these high-terraced gravel deposits of the river Somme, and in his book he now gave, in the first full form, the results of his labor. So far as France was concerned, he was met at first by what he calls "a conspiracy of silence," and by a contemptuous opposition among orthodox scientists, at the head of whom stood Élie de Beaumont.

This heavy, sluggish opposition seemed immovable: nothing that Boucher could do or say appeared to lighten the pressure of the orthodox theological opinion behind it—not even his belief that these fossils were remains of men drowned at the Deluge of Noah, and that they were proofs of the literal exactness of Genesis seemed to help the matter. His opponents felt instinctively that such discoveries boded danger to the accepted view, and they were right: Boucher himself soon saw the folly of trying to account for them by the orthodox theory which he had adopted at first.

And it must be confessed that not a little force was added to the opposition by certain characteristics of Boucher de Perthes himself; gifted, foresighted, and vigorous as he was, he was his own worst enemy; carried away by his own discoveries, he jumped to the most astounding conclusions: the engravings in the later volume of his great work, showing what he thought to be human features and inscriptions upon some of the flint implements, are worthy of a comic almanac; and at the great National Museum of Archæology at St. Germain, beneath the shelves bearing the remains which he discovered, which mark the triumph of a great new movement in human science, are drawers containing specimens hardly worthy of a penny museum, from which he drew the most unwarranted inferences as to the language, religion, and usages of prehistoric man.

But Boucher triumphed none the less. Among his bitter opponents at first was Dr. Rigollot, who in 1855, searching earnestly for materials to refute the innovator, dug into the deposits of St. Acheul —and was converted: for he found implements similar to those of Abbeville, making still more certain the existence of man during the Drift period. So, too, Gaudry a year later made similar discoveries.

But most important was the evidence of the truth which now came from other parts of France and from many other countries. The French leaders in geological science had been held back, not only by awe of Cuvier, but by recollections of Scheuchzer. Ridicule has always been a serious weapon in France, and the ridicule which finally overtook the adherents of the attempt of Scheuchzer, Mazurier, and others, to square geology with Genesis, was still remembered. From the great body of French scientists, therefore, Boucher secured at first no aid. His support came from the other side of the Channel. The most eminent English geologists, such as Falconer, Prestwich, and Lyell, visited the beds at Abbeville and St. Acheul, convinced themselves that the discoveries of Boucher, Rigollot, and their colleagues were real, and then quietly but firmly told England the truth.

And now there appeared a most effective ally in France. The arguments used against Boucher de Perthes and some of the other early investigators of bone caves had been that the implements found might have been washed about and turned over by great floods, and therefore that they might be of a recent period; but in 1861 Edward Lartet published an account of his own excavations at the Grotto of Aurignac, and the proof that man had existed in the time of the Quaternary animals was complete. This grotto had been carefully sealed in prehistoric times by a stone at its entrance; no interference from disturbing currents of water had been possible; and Lartet found, in place, bones of eight ont

of nine of the main species of animals which characterize the Quaternary period in Europe; upon them were marks of cutting implements, and in the midst of them coals and ashes.

Close upon these came the excavations at Eyzies by Lartet and his English colleague, Christy. In both these men there was a sobriety and a carefulness in making researches and in stating results which converted many of those who had been repelled by the enthusiasm of Boucher de Perthes. The two colleagues found buried together, in the stony deposits made by the water dropping from the roof of the cave at Eyzies, the bones of numerous animals extinct or departed to arctic regions, one of these a vertebra of a reindeer with a flint lance-head still fast in it, and with these were found evidences of fire.

Discoveries like these were thoroughly convincing. But there still remained here and there a few gainsayers in the supposed interest of Scripture, and these, in spite of the convincing array of facts, insisted that in some way, by some combination of circumstances, these bones of extinct animals of vastly remote periods might have been brought into connection with all these human bones and implements of human make in all these different places, without supposing that these ancient relics of men and animals were of the same period. But a new class of discoveries came to silence this contention. At La Madeleine in France, and at various other places, were found rude but striking carvings and engravings on bone and stone representing sundry specimens of those long-vanished species. These specimens, or casts of them, can now be seen in all the principal museums. They show the hairy mammoth, the cave bear, and various other animals of the Quaternary period, carved rudely but vigorously by contemporary men; and, to complete the significance of these discoveries, travelers returning from the icy regions of North America have brought similar carvings of animals now existing in those regions, made by the Eskimos during their long arctic winters to-day.*

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* For the explorations in Belgium, see Dupont, Le Temps Préhistorique en Belgique. For the discoveries by McEnery and Godwin Austin, see Lubbock, Prehistoric Times, London, 1869, chap. x; also Cartailhac, Joly, and others above cited. For Boucher de Perthes, see his Antiquités Celtiques et Antédiluviennes, Paris, 1847–'64, vol. iii, pp. 526 *et seq.* For sundry extravagances of Boucher de Perthes, see Reinach, Description Raisonnée du Musée de St. Germain en Laye, Paris, 1889, vol. i, pp. 16 *et seq.* For the mixture of sound and absurd results in Boucher's work, see Cartailhac as above, p. 19. Boucher had published in 1838 a work entitled De la Création, but it seems to have dropped dead from the press. For the attempts of Scheuchzer to reconcile geology and Genesis by means of the *Homo diluvii testis*, and similar "diluvian fossils," see the chapter on Geology in this series. The original specimens of those prehistoric engravings upon bone and stone may be best seen at the Archæological Museum of St. Germain and the British Museum. For engravings of some of the most recent, see especially Dawkins's Early Man in Britain, chap. vii, and the Catalogue du Musée du St. Germain. For comparison of this prehistoric work with that

As a result of these discoveries and others like them, showing that man was not only a contemporary with long-extinct animals of past geological epochs, but that he had already developed into a stage of culture above pure savagery, the tide of thought began to turn. Especially was this seen in 1863, when Lyell published the first edition of his Geological Evidence of the Antiquity of Man; and the fact that he had so long opposed the new ideas gave force to the clear and conclusive argument which led him to renounce his early scientific beliefs.

Research among the evidences of man's existence in the early Quaternary, and possibly in the Tertiary period, was now pressed forward along the whole line. In 1864 Gabriel Mortillet founded his review devoted to this subject; and in 1865 the first of a series of scientific congresses devoted to such researches was held in Italy. These investigations went on vigorously in all parts of France and spread rapidly to other countries. The explorations which Dupont began in 1864, in the caves of Belgium, gave to the museum at Brussels eighty thousand flint implements, forty thousand bones of animals of the Quaternary period, with a number of human skulls and bones found mingled with these remains. From Germany, Italy, Spain, America, India, and Egypt similar results were reported.

Especially noteworthy were the further explorations of the caves and drift throughout the British Islands. The discovery by Colonel Wood in 1861, of flint tools in the same strata with bones of the earlier forms of the rhinoceros, was but typical of many. A thorough examination of the caverns of Brixham and Torquay, by Pengelly and others, made it still more evident that man had existed in the early Quaternary period: the existence of a period before the Glacial epoch or between different glacial epochs in England, when the Englishman was a savage, using rude stone tools, was then fully ascertained, and, what was more significant, there were clearly shown a gradation and evolution even in the history of that period. It was found that this ancient Stone epoch showed progress and development: in the upper layers of the caves, with remains of the reindeer, who, although he has migrated from these regions, still exists in more northern climates, were found stone implements revealing some little advance in civilization; next below these, sealed up in the stalagmite, came, as a rule, another layer, in which the remains of reindeer were rare and those of the mammoth more frequent, the implements found in this stratum being less skillfully made than

produced to-day by the Eskimos and others, see Lubbock, Prehistoric Times, chapters x and xiv. For very striking exhibitions of this same artistic gift in a higher field to-day by descendants of the barbarian tribes of northern America, see the very remarkable illustrations in Rink, Danish Greenland, London, 1877, especially those in chap. xiv.

those in the upper and more recent layers; and, finally, in the lowest levels, near the floors of these ancient caverns, with remains of the cave bear and others of the most ancient extinct animals, were found stone implements evidently of a yet ruder and earlier stage of human progress. No fairly unprejudiced man can visit the cave and museum at Torquay without being convinced that there were a gradation and evolution in these beginnings of human civilization. The evidence is complete; the masses of breccia taken from the cave, with the various soils, implements, and bones carefully kept in place, put this progress beyond a doubt.

All this indicated a great antiquity for the human race; but in it lay the germs of still another great truth, even more important and more serious in its consequences to the older theologic view, and this will be discussed in the following chapter.

But new evidences came in, showing a yet greater antiquity of man. Remains of animals were found in connection with human remains, which showed not only that man was living in times more remote than the earlier of the new investigators had dared dream, but that some of these early periods of his existence must have been of immense length, embracing climatic changes betokening different geological periods: for with remains of fire and human implements and human bones were found not only bones of the hairy mammoth and cave bear, woolly rhinoceros and reindeer, which could only have been deposited there in a time of arctic cold, but bones of the hyena, hippopotamus, saber-toothed tiger, and the like, which could only have been deposited when there was in these regions a torrid climate. The conjunction of these remains clearly showed that man had lived in England early enough and long enough to pass through times when there was arctic cold and times when there was torrid heat; times when great glaciers stretched far down into England and indeed into the continent, and times when England had a land connection with the European continent, and the European continent with Africa, allowing tropical animals to migrate freely from Africa to the middle regions of England.

The question of the origin of man at a period vastly earlier than the sacred chronologists permitted was thus absolutely settled; but among the questions regarding the existence of man at a period yet more remote, the Drift period, there was one which for a time seemed to give the champions of science some difficulty. The orthodox leaders in the time of Boucher de Perthes, and for a considerable time afterward, had a weapon of which they made good use; the statement that no human bones had yet been discovered in the drift. The supporters of science

naturally answered that few if any other bones as small as those of man had been found, and that this fact was an additional proof of the great length of the period since man had lived with the extinct animals; for, since specimens of human workmanship proved man's existence as fully as remains of his bones could do, the absence or even rarity of human and other small bones simply indicated the long periods of time required for dissolving them away.

Yet Boucher, inspired by the genius he had already shown, and filled with the spirit of prophecy, declared that human bones would yet be found in the midst of the flint implements, and in 1863 he claimed that this prophecy had been fulfilled by the discovery at Moulin Quignon of a portion of a human jaw deep in the early Quaternary deposits. But his triumph was short-lived; the opposition ridiculed his discovery; they showed that he had offered a premium to his workmen for the discovery of human remains, and they naturally drew the inference that some tricky laborer had deceived him. The result of this was, that the men of science felt obliged to acknowledge that the Moulin Quignon discovery was not proved.

But ere long human bones were found in the deposits of the early Quaternary period, or indeed of an earlier period, in various other parts of the world, and the question regarding the Moulin Quignon relic was of little importance.

We have seen that researches regarding the existence of prehistoric man in England and on the Continent were at first mainly made in the caverns; but the existence of man in the earliest Quaternary period was confirmed on both sides the English Channel, in a way even more striking, by the close examination of the drift and early gravel deposits. The results arrived at by Boucher de Perthes were amply confirmed in England. Rude stone implements were found in terraces a hundred feet and more above the levels at which various rivers of Great Britain now flow, and under circumstances which show that, at the time when they were deposited, the rivers of Great Britain in many cases were entirely different from those of the present period, and formed parts of the river system of the European continent. Researches in the high terraces above the Thames, the Ouse, as well as at other points in Great Britain, placed beyond a doubt the fact that man existed on the British Islands at a time when they were connected by solid land with the Continent, and made it clear that, within the period of the existence of man in northern Europe, a large portion of the British Islands had been sunk to depths between fifteen hundred and twenty-five hundred feet beneath the Northern Ocean—had risen again from the water—had formed part of the continent of Europe, and had been in

unbroken connection with Africa, so that elephants, bears, tigers, lions, the rhinoceros and hippopotamus, of species now mainly extinct, had left their bones in the same deposits with human implements as far north as Yorkshire. Moreover, connected with this fact came in the new conviction, forced upon geologists by the more careful examination of the earth and its changes, that such elevations and depressions of Great Britain and other parts of the world were not the results of sudden cataclysms, but of slow processes extending through vast cycles of years—processes such as are now known to be going on in various parts of the world. Thus it was that the six or seven thousand years allowed by even the most liberal theologians of former times were seen more and more clearly to be but as a mere nothing in the long succession of ages since the appearance of man.

Confirmation of these results came from various other parts of the world, especially from the drift deposits both on the eastern and western coasts of America. The discoveries at Trenton, New Jersey, and at various places in Delaware, Ohio, Minnesota, and elsewhere, along the southern edge of the drift of the glacial epochs, clinched the new scientific truth yet more firmly; and the statement made by an eminent American authority is, that "man was on this continent when the climate and ice of Greenland extended to the mouth of New York Harbor." The discoveries of prehistoric remains on the Pacific coast, and especially in British Columbia, finished completely the last chance at a reasonable contention by the adherents of the older view. As to these investigations on the Pacific slope of the United States, the discoveries of Whitney and others in California had been so made and announced that the judgment of scientific men regarding them was suspended until the visit of perhaps the greatest living authority in his department, Alfred Russel Wallace, in 1887. He confirmed the view of Prof. Whitney and others with the statement that "both the actual remains and works of man found deep under the lava-flows of Pliocene age show that he existed in the New World at least as early as in the Old." To this may be added the discoveries in British Columbia, which prove that, since man existed in these regions, "valleys have been filled up by drift from the waste of mountains to a depth in some cases of fifteen hundred feet; this covered by a succession of tuffs, ashes, and lava-streams from volcanoes long since extinct, and finally cut down by the present rivers through beds of solid basalt, and through this accumulation of lavas and gravels." The immense antiquity of the human remains in the gravels of the Pacific coast is summed up by a most eminent English authority and declared to be proved, "first, by the present river systems being of subsequent date, sometimes cutting through them and their superin-

cumbent lava-cap to a depth of two thousand feet; secondly, by the great denudation that has taken place since they were deposited, for they sometimes lie on the summits of mountains six thousand feet high; thirdly, by the fact that the Sierra Nevada has been partly elevated since their formation." *

As an important supplement to these discoveries of ancient implements came sundry comparisons made by eminent physiolo-

* For the general subject of investigations in British prehistoric remains, see especially Boyd Dawkins, Early Man in Britain and his Place in the Tertiary Period, London, 1880. For Boucher de Perthes's account of his discovery of the human jaw at Moulin Quignon, see his Antiquités Celtiques et Antédiluviennes, vol. iii, pp. 542 *et seq.*, Appendix. For an excellent account of special investigations in the high terraces above the Thames, see J. Allen Brown, F. G. S., Palæolithic Man in Northwest Middlesex, London, 1887. For discoveries in America, and the citation regarding them, see Wright, The Ice Age in North America, New York, 1889, chap. xxi. Very remarkable examples of these specimens from the drift at Trenton may be seen in Prof. Abbott's collections at the University of Pennsylvania. For an admirable statement, see Prof. Henry W. Haynes, in Wright, as above. For proofs of the vast antiquity of man upon the Pacific coast, cited in the text, see Skertchley, F. G. S., in the Journal of the Anthropological Institute for 1887, p. 336; see also Wallace, Darwinism, London, 1890, chap. xv; and for a summary, as cited, Laing, Problems of the Future, London, 1889. For a striking summary of the evidence that man lived before the last submergence of Britain, see Brown, Palæolithic Man in Northwest Middlesex, as above cited. For proofs that man existed in a period when the streams were flowing hundreds of feet above their present level, see ibid., p. 33. As to the evidence of the action of the sea and of glacial action in the Welsh bone caves after the remains of extinct animals and weapons of human workmanship had been deposited, see ibid., p. 198. For a good statement of the slowness of the submergence and emergence of Great Britain, with an illustration from the rising of the shore of Finland, see ibid., pp. 47, 48. As to the flint implements of Palæolithic man in the high-terraced gravels throughout the Thames Valley, associated with bones of the mammoth, woolly rhinoceros, etc., see Brown, p. 31. For still more conclusive proofs that man inhabited North Wales before the last submergence of the greater part of the British Islands to a depth of twelve hundred to fourteen hundred feet, see ibid., pp. 199, 200. For maps showing the connection of the British river system with that of the Continent, see Boyd Dawkins, Early Man in Britain, London, 1880, pp. 18, 41, 73; also, Lyell, Antiquity of Man, chap. xiv. As to the long continuance of the early Stone period, see James Geikie, The Great Ice Age, New York, 1888, p. 402. As to the impossibility of the animals of arctic and torrid regions living together or visiting the same place at different times in the same year, see Geikie, as above, pp. 421 *et seq.*; and for a conclusive argument that the animals of the period assigned lived in England, not since, but before, the Glacial period, or in the interglacial period, see ibid., p. 459. For a very candid statement by perhaps the foremost leader of the theological rear-guard, admitting the insuperable difficulties presented by the Old Testament chronology as regards the creation and the deluge, see the Duke of Argyll's Primeval Man, pp. 90–100, and especially pp. 93, 124. For a succinct statement on the general subject, see Laing, Problems of the Future, London, 1889, chapters v and vi. For discoveries of prehistoric implements in India, see notes by Bruce Foote, F. G. S., in the British Journal of the Anthropological Institute for 1886 and 1887. For similar discoveries in South Africa, see Gooch, in Journal of the Anthropological Institute of Great Britain and Ireland, vol. xi, pp. 124 *et seq.* For proofs of the existence of Palæolithic man in Egypt, see Mook, Haynes, Pitt-Rivers, and others, cited at length in the next chapter. For the corroborative and concurrent testimony of ethnology, philology, and history to the vast antiquity of man, see Tylor, Anthropology, chap. i.

gists between human skulls and bones found in different places and under circumstances showing vast antiquity.

Human bones had been found under these circumstances as early as 1835 at Canstadt near Stuttgart, and in 1856 in the Neanderthal near Düsseldorf; but in more recent searches they have been discovered in a multitude of places, especially in Germany, France, Belgium, England, the Caucasus, Africa, and North and South America. But comparison of these bones showed that even in that remote Quaternary period there were great differences of race, and here again came in an argument for the yet earlier existence of man on the earth; for long previous periods must have been required to develop such racial differences. Considerations of this kind have given a new impulse to the belief that man's existence dates back at least into the Tertiary period. The evidence for this earlier origin of man has been ably summed up not only by its brilliant advocate, Mortillet, but by a former opponent, one of the most conservative of modern anthropologists, Quatrefages; and the conclusion arrived at by both is, that man did really exist in the Tertiary period. The acceptance of this conclusion is also seen in the recent work of that most able investigator, Alfred Russel Wallace, who, cautious and conservative as he is, places the origin of man not only in the Tertiary period, but in an earlier stage of it than most have dared assign; even in the Miocene.

The first thing raising a strong presumption, if not giving proof, that man existed in the Tertiary, was the fact that from all explored parts of the world came in more and more evidence that in the earlier Quaternary man existed in different, strongly marked races and in great numbers. From all regions which geologists had explored, even from those the most distant and different from each other, came this same evidence—from northern Europe to southern Africa; from France to China; from New Jersey to British Columbia; from British Columbia to Peru. The development of man in such numbers and in so many different regions, with such differences of race and at so early a period, must have required a long previous time.

This argument seemed to be strengthened by discoveries of bones bearing marks apparently made by cutting instruments, in the Tertiary formations of France and Italy, and by the discoveries of what were claimed to be flint implements by the Abbé Bourgeois in France, and of implements and human bones by Prof. Capellini in Italy.

On the other hand, some of the more cautious men of science are content to say that the existence of man in the Tertiary period is not yet settled. As to his existence throughout the Quaternary epoch no new proofs are needed. Even so determined a supporter

of the theological side as the Duke of Argyll has been forced to yield to the evidence.

Of attempts to make an exact chronological statement throwing light on the length of the various prehistoric periods, the most notable have been those by M. Morlot, on the accumulated strata of the Lake of Geneva; by Gilliéron, on the silt of Lake Neufchâtel; by Horner, in the delta deposits of Egypt; and by Riddle, in the delta of the Mississippi. But while these have failed to give anything like an exact result, all these investigations together point to the one great truth so amply established, of the vast antiquity of man, and the utter inadequacy of the orthodox chronology based by theologians upon our sacred books. The period of man's past life upon our planet, which has been fixed by the universal Church, "always, everywhere, and by all," is thus perfectly proved to be merely trivial compared with those vast geological epochs during which man is now known to have existed.*

GREENLAND AND THE GREENLANDERS.†

By ELISÉE RECLUS.

TILL recently Hooker, Payer, and others supposed that the interior of Greenland presented vast spaces free of ice, grassy valleys where herds of reindeer grazed, and popular legends were appealed to in support of this view. Nordenskjöld also suggested that the phenomenon might be explained by the action of the winds, which after crossing the inland ranges descended in warm currents like the *föhn* of Switzerland, and thus melted the snows of the valleys. But the systematic researches made in recent years have failed to discover any of these inland oases. The whole land appears, on the contrary, to be covered with a continuous ice-cap fringed by glaciers which move down the outer valleys to the neighborhood of the sea, or to the fiords of the periphery. The valleys themselves have disappeared, and, despite local irregu-

* As to the evidence of man in the Tertiary period, see works already cited, especially Quatrefages, Cartailhac, and Mortillet. For a summary, see Laing, as above, pp. 103–105. See also, for a summing up of the evidence in favor of man in the Tertiary period, Quatrefages, Histoire Général des Races humaines, in the Bibliothèque Étymologique, Paris, 1887, chap. iv. As to the earlier view, see Vogt, Lectures on Man, London, 1864, lecture xi. For a thorough and convincing refutation of Sir J. W. Dawson's attempt to make the old and new Stone periods coincide, see H. W. Haynes, in chap. vi of the History of America, edited by Justin Winsor. For development of various important points in the relation of anthropology to the human occupancy of our planet, see Topinard, Anthropology, London, 1890, chap. ix.

† From advance sheets of North America, by Elisée Reclus, soon to be published by D. Appleton & Co., being the fifteenth volume of The Earth and its Inhabitants.

larities, the ice-cap slopes like a shield uniformly toward the interior. Thus, in certain places the explorer should expect to meet elevations of seven thousand or eight thousand feet; but, owing to an optical illusion, he scarcely knows whether he is climbing or descending. The horizon seems to rise on all sides, says Nordenskjöld, "as if he were at the bottom of a basin."

The aspect of these boundless wastes rolling away in scarcely perceptible undulations, and in the distance mingling the gray of their snows with the gray of the skies, at first gave the impression that Greenland was a uniform plateau, a sort of horizontal table. The belief now prevails that the rocky surface of the land is, on the contrary, carved into mountains and hills, valleys and gorges, but that the plastic snows and ice have gradually filled up all the cavities, which now show only in slight sinuosities on the surface. Allowing to the whole mass of the ice-cap an average thickness of five hundred feet, it would represent a total volume of about one hundred and fifty thousand cubic miles. This *sermer suak*, or "great ice" of the Greenlanders, flows like asphalt or tar with extreme slowness seaward, while the surface is gradually leveled by the snow falling during the course of ages and distributed by the winds. In the interior of the country the surface of the ice and snow is as smooth as if it were polished, looking like "the undisturbed surface of a frozen ocean, the long but not high billows of which rolling from east to west are not easily distinguishable to the eye."* Nevertheless, the exterior form of the ice-cap has been greatly diversified, at least on its outer edge, where in many places it is difficult to cross, or even quite impassable. The action of lateral pressure, of heat produced by the tremendous friction, of evaporation and filtration, has often broken the surface into innumerable cones a few yards high, in form and color resembling the tents of an encampment. The depressions of the snowy plateau are filled with meres, lagoons, and lakes; streams and rivulets excavate winding gorges with crystal walls in the snow and ice. Cascades, frozen at night, plunge during the day into profound crevasses; during the expedition of 1870 Nordenskjöld saw intermittent jets of water rising to a great height, which he was unable to study, but which he supposes must be geysers.

Most of the glaciers reaching the coast round the Greenland seaboard present a somewhat regular frontal line, from which blocks of varying size break off with every wave and drift away with the current. But the frozen streams which yield those huge masses large enough to be called icebergs, that is, "mountains of ice," are relatively few in number, their production requiring a combination of favorable circumstances, such as the thickness of

* Nansen, Proceedings of the Royal Geographical Society, August, 1889.

the parent glacier, the form of its bed, and the depth of the water at its mouth. The larger fragments originate for the most part along that remarkable break which is presented in the normal formation of the coast-line between Egedesminde and the Svartenhuk Peninsula. Rink enumerates not more than thirty Greenland glaciers which discharge really large icebergs, and of this number only six or eight yield blocks of the first magnitude.

The average velocity of the congealed masses is about fifty feet in the twenty-four hours, but in some places a much greater speed has been recorded, though still varying considerably with the seasons. A branch of the Augpadlartok glacier, north of Upernavik, moves at the rate of one hundred feet a day, the highest yet measured. But how enormous must be the pressure of the inland ice-fields to discharge into the sea the vast quantities of icebergs which are yearly sent adrift along the Greenland seaboard! Estimated in a single block the annual discharge from each of the five best-known glaciers would represent a mass of about seventeen billion cubic feet in capacity, and fifty-six hundred feet in height, depth, and thickness. Reduced to a liquid state this mass would be equivalent to a stream discharging seaward five hundred cubic feet per second, or 15,500,000 a year.

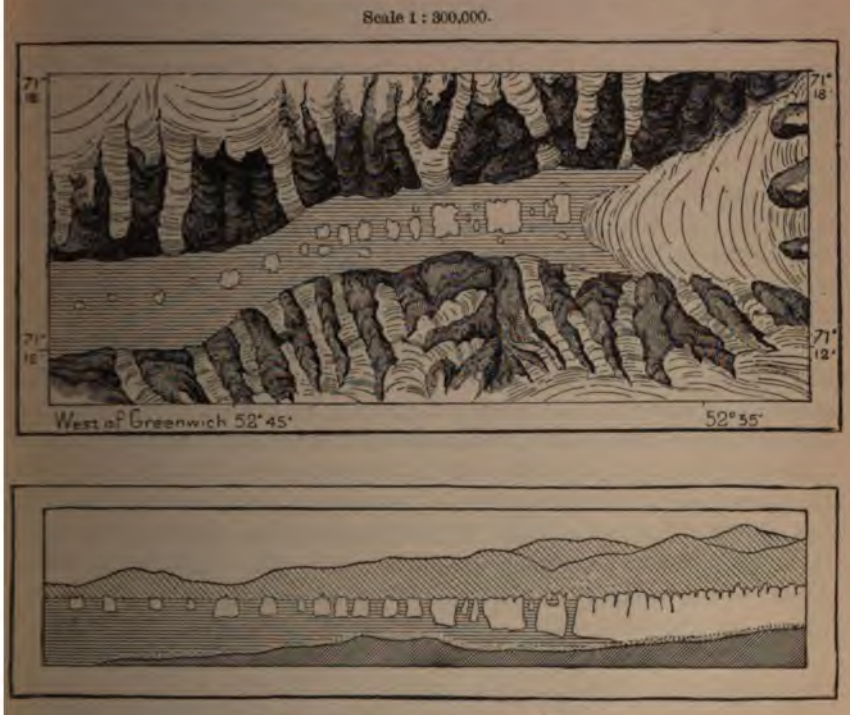
The formation of this drift ice, or floating icebergs, is one of those phenomena which were discussed long before the seaboard had been studied, or before the breaking away of the frozen masses had actually been witnessed. Wherever the glaciers discharge through a broad valley preserving a uniform width and depth for a considerable space, and advancing seaward through a fiord of like dimensions, and with gently sloping bed, the ice may progress without any of those accidents caused by the inequalities of more rugged channels. Under such conditions the compact mass glides smoothly forward over its rocky bed without developing any rents or fissures. But as it moves down like a ship on its keel, it tends to rise, being at least one twentieth lighter than the displaced water. It is also left without support by the sudden fall of its bed beyond the normal coast-line. Nevertheless, it still continues its onward movement through the waters to a point where its weight prevails over its force of cohesion with the frozen stream thrusting it forward. At this point it snaps off suddenly with a tremendous crash, and the iceberg, enveloped in a thousand fragments projected into space, plunges into the abyss and whirls round and round to find its center of gravity amid the troubled waters. On recovering from the bewilderment caused by all this tumult and chaos, the spectator finds that the glacier has apparently receded a long way toward the head of the bay, in the middle of which a crystal peak is seen slowly drifting away with the current. In this he recognizes the huge fragment detached

FIG. 1.—VIEW ON THE GLACIER OF SERMITSIALIK, NEAR IVIGTUT.

FIG. 1.—FRONT OF THE GLACIER OF ROSENLAUI.

from the glacier, though seldom able to detect its primitive form, the greater part, say at least six sevenths of its volume, sinking below the surface.

If Greenland, like other regions, passed through a glacial epoch, the fossil remains preserved in its sedimentary rocks show that it had also its hot and temperate periods. The old formations



The scale of heights is 50 times greater than that of lengths.

FIG. 3.—MOVEMENT OF THE KANDERDLUG-SUAK GLACIER, UMANAK DISTRICT.

which have yielded Carboniferous, Triassic, and Jurassic fossils, present types of organisms comparable to those at present found in the torrid zone. The upper chalk beds, abounding in vegetable forms, analogous to those of the subtropical and temperate zones, had already been examined by Giesecke at the beginning of this century. They supplied to Nordenskjöld a very remarkable flora, especially rich in dicotyledonous plants represented by numerous families of *Cycadea*, a tree-fern, and even a bread-fruit tree. At that time the mean temperature must have been as high as 68° Fahr.

The Miocene flora, whose general physiognomy corresponds to a more temperate climate, averaging about 53° or 54° Fahr., is illustrated by splendid specimens discovered chiefly in Disco Island

and the surrounding peninsulas. Quite a fossil forest is buried under the ferruginous mass of Mount Atanekerdluk, a peak which rises to a height of over a thousand feet over against Disco, and which is now surrounded by glaciers on all sides. From these deposits Whymper, Nordenskjöld, and others have extracted one hundred and sixty-nine species of plants, of which about three fourths were shrubs and trees, some with stems as thick as a man's body. Altogether there have been discovered in the Greenland strata as many as six hundred and thirteen species of fossil plants. The most prevalent tree is a *Sequoia*, closely resembling the Oregon and Californian giants of the present epoch. Associated with this conifer were beeches, oaks, evergreen oaks, elms, hazel-nuts, walnuts, magnolias, and laurels; and these forest trees were festooned with the vine, ivy, and other creepers. A leaf of a *Cycadea* found among these fossil remains is the largest ever seen; and a true palm, the *Flabellaria*, has been discovered among the remains of these old arctic forests.

To develop such a flora the climate of north Greenland must at that time have been analogous to that at present enjoyed on the shores of Lake Geneva, twenty-four degrees nearer to the equator. According to the same gradation of temperature, the dry lands about the north pole itself must at the same epoch have had their forests of aspens and conifers. According to Oswald Heer, the change that has taken place in the climate since then represents a fall of 30° or 40° Fahr. for north Greenland. The interval between these two ages was marked by the Glacial period, whose traces are visible on the west coast.

Although incomparably poorer than that of Miocene times, the present flora of Greenland is sufficient to clothe extensive tracts with a mantle of mosses, grasses, and brushwood. Wherever the snows melt under the influence of the sun or of the warm east winds, herbaceous and other lowly plants spring up even on the exposed *nunatakker*, and to a height of five thousand feet. Owing to the uniform intensity of the solar heat, the summer flora is almost identical on the low-lying coast-lands and highest mountain-tops. True trees occur in the southern districts, where Egede was said to have measured some nearly twenty feet high. But the largest met by Rink during all his long rambles was a white birch fourteen feet high growing amid the rocks near a Norse ruin. Few trees, in fact, exceed five or six feet, while most of the shrubs become trailing plants. Such are the service and alder, which on the coast reach 65° north latitude; the juniper, which advances to 67°; and the dwarf birch, which ranges beyond 72°.

In its general features the Greenland flora, comprising about four hundred flowering plants and several hundred species of lichens, greatly resembles that of Scandinavia. Hooker and Dr.

Robert Brown regard it as essentially the same as that of the north European highlands and lacustrine regions. Even on the west coast, facing America, this European physiognomy is said to prevail, although to a less degree than on the opposite side, which appears to be much poorer in vegetable forms. But, though limited, the American element is important, supplying to the natives numerous edible berries, algæ, and fuci, which have saved whole tribes from starvation during periods of scarcity. The Europeans have also their little garden-plots, where they grow lettuce, cabbage, turnips, and occasionally potatoes about the size of schoolboys' marbles.

The great bulk of the present population consists of Danes, Danish half-breeds, and the Eskimo proper, more or less modified by crossings with the early Norse settlers. Nearly all the inhabitants, already Christianized and civilized by the missionaries, are grouped in parishes, whose organization differs from corresponding European communities only in those conditions that are imposed by the climate and the struggle for existence. There still survive, however, a few tribes of pure Eskimo stock, such as those recently discovered by European explorers beyond the Danish territory north of Melville Bay and on the east coast. Others also may perhaps exist along the shores of unvisited or inaccessible fiords. But the most northern camping-ground hitherto discovered is that of Ita (Etah), situated in Port Foulke on Smith Sound, in 78° 18′ north latitude. In 1875 and again in 1881 it was found abandoned; but it is known to have been previously inhabited, and the natives had returned to the place in 1882 and 1883.* When visited by Hall and his party, this little group of twenty persons, who had never seen any other human beings, fancied that the strangers were ghosts, the souls of their forefathers descending from the moon or rising from the depths of the abyss. In their eyes the ships of John Ross were great birds, with huge, flapping wings.

Among the Greenland Eskimo are most frequently found men of average and even high stature, especially on the east coast. Most of those on the west side are short, but thick-set and robust, with short legs, small hands, and a yellowish-white complexion. The face is broad and flat, the nose very small, the eyes brown and slightly oblique like the Chinese; the hair black, lank, and falling over the forehead; the expression mild, suggesting that of the seal, the animal which is ever in their thoughts, and whose death is their life. They have also the seal's gait and carriage, as well as a rounded figure well lined with fat to protect it from the cold. What essentially distinguishes the Eskimo from the Mongolian, with whom he was till recently affiliated, is the extremely "doli-

* Greely, Three Years of Arctic Service.

chocephalous" form of his head, the skull, with its vertical sides and sharp crest, often affecting a "scaphocephalous" or boat-like shape. According to Dall, the cranial capacity is higher than that of the red-skins.

Both sexes are dressed very much alike. European fashions, however, have already penetrated among the Greenlanders, and in many districts men are now met wearing the garb of European laborers, while the women deck themselves with cotton stuffs and many-colored ribbons. But in winter no costume could advantageously replace their capacious boots, sealskin pantaloons, close-fitting jacket, and the *amaut*, or hood which "keeps baby warm." In Danish Greenland the women no longer tattoo their chin, cheeks, hands, or feet, nor do they now insert variegated threads under the skin, the missionaries having interdicted these "pagan" practices. Singing, dancing, the relation of the old legends, even athletic games among the young people, were also formerly sternly repressed. Indulgence in strong drinks is allowed only once a year, on the anniversary of the King of Denmark, and the royal monopoly of the trade with Greenland is justified on the ground that in this way the importation of spirits is prevented.

FIG. 4.—GREENLAND ESKIMO.

Possessing great natural intelligence combined with love of instruction, the Greenlanders may justly claim to be civilized. The great majority read and write their mother-tongue, and sing European melodies, while several speak English or Danish. Nearly all the families have their little library, and read their Eskimo newspaper, as well as the collections of national legends, illustrated with engravings by native artists. Greenland even

FIG. 5.—VIEW OF UPERNAVIK.

possesses at least one original work, the account of the voyages of Hans Hendrik, companion of Kane, Hall, Hayes, and Nares.

Formerly, the right of property was restricted to objects of personal use, such as clothes and weapons; the hunting-grounds belonged to the whole community, and the produce of the chase or fisheries was equally distributed among all. The rights of communal property were also regulated and safeguarded by general assemblies followed by public banquets. But the Europeans have changed all that by introducing the principle of sale and purchase, by enlarging to their own profit the rights of personal ownership, and proclaiming the new gospel of "every man for himself." The result is a general impoverishment and moral degradation of the people. They are no longer like the Eskimo visited by Graah on the east coast—"the gentlest, the most upright and virtuous of men." Nevertheless, the language possesses not a single abusive term, and it is impossible to swear in Eskimo.

The part of Greenland where Eric the Red built his stronghold, and where the banished Norsemen flocked around him, is still one of the least deserted regions, as it also is the most fertile and temperate. Julianahaab, capital of this district, contains one fourth of the entire population of the country grouped on the banks of a small stream in a grassy valley near a deep fiord, which is unfortunately not easily accessible to shipping.

Upernivik (Upernavik) and Tasiusak, lying still farther north in 73° 24′ north latitude, are the last European settlements in Greenland, gloomy abodes lost amid the snows at the foot of yellowish or brick-red rocks. In winter the sun sets for eighty days, yet by a sort of mockery this glacial district bears an Eskimo name meaning "spring." The horrors of war were extended to this extremity of the habitable world at the beginning of the present century, when Upernavik was burned by the English whalers, and all communication between Greenland and Denmark interrupted for the seven years from 1807 to 1814.

THE Siamese Government is taking great pains to encourage the speedy development of the enormous potential resources of the country, and has sagaciously done much in that direction. Telegraphs have been established; schools, hospitals, and other public buildings have been erected, and are increasing every day. A tramway company, supported mainly by Siamese capital, is running street cars in the metropolis. A river flotilla company, wholly Siamese, carries the passenger traffic of the stream on which Bangkok is built; important gold-mining operations have been begun by a company, in which a majority of the subscribers are Siamese; and a trunk line of railway is under contract. A large and lucrative export trade in cattle has sprung up; and mills, docks, and fleets of German and English ships, all doing a flourishing business, attest the prevalence of a spirit of enterprise.

EVOLUTION AND THE DISTRIBUTION OF ANIMALS.*

By DAVID STARR JORDAN,
PRESIDENT OF THE UNIVERSITY OF INDIANA.

I.

NO one with good eyes and brains behind them has ever looked forth on the varied life of the world—on forest or field or brook or sea—without at least once asking himself this question: "What is the cause of nature's endless variety?" We see many kinds of beasts and birds and trees and flowers and insects and blades of grass, yet when we look closely we find not one grass-blade in the meadow quite like another blade. Not one worm is like its fellow-worm, and not one organism in body or soul is the measure of its neighbor. You may search all day to match one clover-leaf, and, should you succeed, even then you have failed; for, if the two leaves agree in all physical respects, they may still be unlike in that which we can not see, their ancestries, their potentialities. Again, with each change of conditions, of temperature, of moisture, of space, of time, with each shifting of environment, the range in variety increases. "Dauer in Wechsel" (persistence in change); "this phrase of Goethe," says Amiel, "is a summing up of nature." And the naturalist will tell you that the real variety is far greater than that which appears. He will tell you that, where commonness seems to prevail, it is the cover of variety. The green cloak which covers the brown earth is the shelter under which millions of organisms, brown or green, carry on their life-work.

Each recognizable kind of animal or plant is known in biology as a species. The number of forms now considered as distinct species is far beyond the usual conception of those who have not made a special study of such matters. I have an old book in my library, the tenth edition of the Systema Naturæ, published by Linnæus in 1758. This book treats of all the species of animals known a little more than a century ago. In its eight hundred and twenty-three pages some four thousand different kinds of animals are named and briefly described. But for every one of these enumerated by Linnæus, more than one hundred kinds are known to the modern naturalist, and the number of species still unknown doubtless exceeds the number of those already recorded. Every year for the last quarter of a century there has been published in London a plump octavo volume known as the Zoölogical Record. Each of these volumes, larger than the whole Systema

* An address delivered before the Chicago Institute, in a course on the Testimony of Science in regard to Evolution.

Naturæ, contains the names of the species new to science added to our lists during the year of which it treats; and in the record of each year we find the names of two or three times as many as are mentioned in the whole Systema Naturæ. Yet the field shows no signs of exhaustion. As these volumes stand on the shelf together, it is easy to see that the later volumes are the thickest, and that the record for the present year is the largest of all. The additional species named and described in 1889 are more than ten thousand. Moreover, what is true of the increase of knowledge in systematic zoölogy, is even more marked in the case of botany. Such, then, is the variety of life on the globe—a variety of which Linnæus and his successors had never dared to dream.

And yet, great as this variety is, there are, after all, only a few types of structure among all animals and plants—some three or four or eight or ten general modes of development—all the rest being minor variations from these few types.

It is even true that all life is but a series of modifications of a single plan; for all organisms are composed of cells, the essential element of which is always a single substance—protoplasm. All are governed by the same laws of development, reproduction, and susceptibility to outside influences. Unity in life is therefore not less a fact than is life's great diversity. In whatever way we account for the diversity, the essential unity must not be forgotten. The bonds of unity among organisms constitute what the naturalist calls homology.

That these resemblances have some deep significance, no thoughtful student of nature has ever doubted. What this significance may be is the underlying question in that branch of philosophy which has come to be known as evolution.

In the present discussion I shall take for granted that answer to these questions which is associated with the name of Darwin; and, as a student of the relations and distribution of animals, I firmly believe that no answer to these questions fundamentally different from his will ever be possible.

The essence of the Darwinian theory is this, that the various species of the present day are all derived from pre-existing forms, more or less unlike them; that this derivation takes place through the operation of natural laws—the law of heredity, the law of response to external stimulus or environment, and the law less clearly understood by which variations from ancestral types are constantly produced; the "divine initiative" in the individual which struggles against sameness and monotony. The constant tendency of organisms to multiplication by geometric progression in a world of limited extent, already apparently full, brings about a constant struggle for existence among these organisms, and by this struggle we have the progressive adjustment of individuals

to their environment—an adjustment which is made more and more complete by the ceaseless destruction of the unadjusted. According to this theory, the same causes which have produced difference of species in the past must be still at work, and must continue to produce similar differences in the future. To the theory of derivation is opposed the old idea of "special creation." But this theory of special creation has never had in science other than a provisional existence. It was a mere name for a process not understood. If each of the millions of species of animals and plants living and extinct came about by a "special creation," then special creation can not be an operation outside the limits of law. It is simply the name given in ignorance to the law by which species are produced. What has been done so many times must be done in some uniform way. What this way is, the theory of evolution professes in some degree to define.

The fact is, the theory of development gives the only clew by which the naturalist can be guided in his work. If the mutual affinities of species do not depend on the law of heredity, they are unintelligible. They are impossible. If the variation of species is really immutability in disguise, we can not trust our senses. We are left to choose between some form of the development theory and a hopeless unscientific agnosticism, content with the surface facts, and ignorant of the laws of which these facts are the expression.

I do not wish to-night to discuss either the general question of evolution nor that special theory of the method of evolution which is associated with the name of the master of modern zoölogy. I shall take evolution and Darwinism for granted, and confine myself to a statement of certain facts and principles in the science of zoögeography and to their bearing on the question of the origin of species. There are many difficulties in bringing the facts of this science down to the needs of concrete illustration. A science so broad as to include all human history at once with the history of every group of animated organisms can not well be compressed into a discussion of a single hour. And with this I may recall the additional difficulty, present in all discussions of the subject of evolution, of distinguishing single illustrations from arguments. Isolated cases of geographical variations in species would not have great value as arguments for the development theory were the cases really isolated. The force lies in this fact, that these cases are typical; that what may be said of one is true of a thousand.

In like manner the full force of the laws of homology and heredity can only be felt when their effect is cumulative, as in the mind of the anatomist who has followed each organ through its protean disguises in a wide range of forms.

Still, again, the force of the argument drawn from embryology does not come from a knowledge of the changes in a single egg. All these studies need the second premise, obtained by years of comparison in different fields of investigation, that no case is isolated. Without this premise, the argument would be incomplete. The few cases of development or change which can be brought to popular notice are simply illustrations and not proofs.

As Prof. Bergen has well said, "it is important that we should understand that none of the kinds of evidence in favor of evolution loses so much by being represented only by scattered instances as the argument from distribution." And, conversely, no argument is so strong when all the known facts are brought into consideration together. The universal fact of the mutability of species can be really understood or appreciated only by him by whose eyes multitudes of species have been seen to change. To the ordinary observer the species seems constant, just as the face of a cliff seems constant. To the student of nature mutability is everywhere. Just as the wind and rain and frost quietly but surely change the face of a cliff, so do other forces of nature as quietly but as surely change the face of a species.

And now we may notice that it was precisely this phase of the subject, the relation of species to geography, which first attracted the attention of both Mr. Darwin and Mr. Wallace.

Both these observers noticed that island life is neither strictly like nor unlike the life of the nearest land, and that the degree of difference varies with the degree of isolation. Both were led from this fact to the theory of derivation, and to lay the greatest stress on the progressive modification resulting from the struggle for existence.

In the voyage of the Beagle, you remember, Mr. Darwin was brought in contact with the singular fauna of the Galapagos Islands, that cluster of volcanic rocks which lies in the open sea some six hundred miles west of the coast of Equador and Peru. The sea birds of these islands are essentially the same as those of the coast of Peru. So with most of the fishes. We can see how this might well be, for both sea birds and fishes can readily pass from the one region to the other. But the land birds, as well as the reptiles, insects, and plants, are mostly peculiar to the islands. The same species are found nowhere else. But other species very much like them in all respects are found, and these all live along the coast of Peru. In the Galapagos Islands, according to Darwin's notes, "there are twenty-six land birds; of these, twenty-one or perhaps twenty-three are ranked as distinct species, and would commonly be assumed to have been here created; yet the close affinity of most of these birds to American species is manifest in every character, in their habits, gestures, and tones of voice. So

it is with the other animals and with a large proportion of the plants. . . . The naturalist, looking at the inhabitants of these volcanic islands in the Pacific, feels that he is standing on American land."

The question, then, is this: If these species have been created as we find them on the Galapagos, why is it that they should all be very similar in type to other animals, living under wholly different conditions, but on a coast not so very far away? And again, why are the animals and plants of another cluster of volcanic islands—the Cape Verde Islands—similarly related to those of the neighboring coast of Africa, and wholly unlike those of the Galapagos? If the animals were created to match their conditions of life, then those of the Galapagos should be like those of Cape Verde, the two archipelagoes being extremely alike in respect to soil, climate, and physical surroundings. If the species on the islands are products of separate acts of creation, what is there in the nearness of the coasts of Africa or Peru to influence the act of creation so as to cause the island species to be, as it were, echoes of those on shore?

If, on the other hand, we should adopt the obvious suggestion that both these clusters of islands have been colonized by immigrants from the mainland, the fact of uniformity of type is accounted for, but what of the difference of species? If the change of conditions from continent to island may on the island cause such great and permanent changes as to form new species from the old, why may not like changes take place on the mainlands as well as on the islands? And if possible on the mainland of South America, what evidence have we that species are permanent anywhere? May they not be constantly changing? May not what we now consider as distinct species be only the present phase in the changing history of the series of forms which constitutes the species?

The study of these and many similar facts can lead to but one conclusion:

These volcanic islands rose from the sea destitute of land life. They were settled by the waifs of wind and of storm, birds and insects blown from the shore by trade winds, lizards carried on drift-logs and floating vegetation. Of these waifs few came perhaps in any one year, and few perhaps of those who came made the islands a home; yet, as the centuries passed on, suitable inhabitants were found. That this is not fancy we know, for we have the knowledge of many similar transfers. Every one who has approached our eastern shores by sea in the face of a storm will realize this. Hosts of land birds—sparrows, warblers, chickadees, and even woodpeckers—are carried out by the wind, a few falling exhausted on the decks of ships, a few others falling on

off-shore islands, like the Bermudas, the remainder drowned in the sea.

Of the immigrants to the Galapagos the majority doubtless die and leave no sign. A few will remain, multiply, and take possession, and their descendants are thus native to the islands. But, isolated from the great mass of their species and bred under new surroundings, these island birds come to differ from their parents and still more from the great mass of the land species of which their ancestors were members. Separated from these, their individuality would assert itself. They would assume with new environment new friends, new foes, new conditions. They would develop qualities peculiar to themselves—qualities intensified by isolation. "Migration," says Dr. Coues, "holds species true; localization lets them slip." This would be more exactly the truth should we say that localization holds peculiarities true; migration lets them slip. Local peculiarities disappear by wide association and are intensified when individuals of similar peculiarities are kept together. Should later migrations of the original land species come to the islands, the individuals surviving would in time form distinct species, or more likely, mixing with the mass of those already arrived, their special characters would be lost in those of the majority.

The Galapagos, first studied by Mr. Darwin, serve to us only as an illustration. The same problems come up in one guise or another in all questions of geographical distribution, whether of continent or island.

The relations of the fauna of different regions are intimate in direct relation to the ease by which barriers may be crossed. Distinctness is in direct proportion to isolation. What is true in this regard of the fauna of any region as a whole is likewise true of any of its individual species. The degree of resemblance among individuals is in direct proportion to the freedom of their movement, and variation within what we call specific limits is again proportionate to the barriers which prevent equal and perfect diffusion.

The various divisions or realms into which the surface of the earth may be divided on the basis of the differences in animal life each has its boundary in the obstacles offered to the spread of the average animal. Each species broadens its range as far as it can. It struggles knowingly or not to overcome the barriers of ocean or river, of mountain or plain, of woodland or desert, of moisture or drought, of cold or heat, of lack of food or abundance of enemies, whatever these barriers may be. Were it not for these barriers, every species would become what only man now is, practically cosmopolitan. Man is pre-eminently the barrier-crossing animal. The degree of hindrance offered by any barrier to the

extension of species is only relative. That which constitutes an impassable barrier to some groups is a high-road to others. The river which opposes the passage of the monkey or the cat would be the king's highway to the frog or the turtle. The waterfall which checks the ascent of the fish would be the chosen home of the ouzel.

In spite of the great variety among the barriers existing on the earth, we may divide the globe roughly into five realms or areas of distribution, having their boundaries in the sea or in differences of climate. One or two of these realms are sharply defined; the others are surrounded by a broad fringe of debatable ground, which forms a region of transition to some other zone.

The largest of these realms is the holarctic realm, which comprises nearly all of Asia, Europe, and North America, the arctic and north temperate zones. The north temperate zone has practically a continuous climate, the chief variations being in elevation and rainfall. The close union of Alaska to Siberia forms an almost unbroken land area from the eastern coast of America around to western Europe. To the south the species increase in number and variety; the arctic regions are remarkable for what they lack, yet the general character of the life is almost unbroken over this vast district. Alfred Russel Wallace refers to this unity of northern life in these words:

"When an Englishman travels by the nearest sea route from Great Britain to northern Japan, he passes by countries very unlike his own both in aspect and in natural productions. The sunny isles of the Mediterranean, the sands and date-palms of Egypt, the arid rocks of Aden, the cocoa-groves of Ceylon, the tiger-haunted jungles of Malacca and Singapore, the fertile plains and volcanic peaks of Luzon, the forest-clad mountains of Formosa, and the bare hills of China pass successively in review, until after a circuitous journey of thirteen thousand miles he finds himself at Hakodadi in Japan. He is now separated from his starting-point by an almost endless succession of plains and mountains, arid deserts or icy plateaus; yet, when he visits the interior of the country, he sees so many familiar natural objects that he can hardly help fancying he is close to his home. He finds the woods and fields tenanted by tits, hedge-sparrows, wrens, wagtails, larks, redbreasts, thrushes, buntings, and house-sparrows, some absolutely identical with our own feathered friends, others so closely resembling them that it requires a practiced ornithologist to tell the difference. . . . There are also, of course, many birds and insects which are quite new and peculiar, but these are by no means so numerous or conspicuous as to remove the general impression of a wonderful resemblance between the productions of such remote islands as Britain and Yesso" (Island Life).

A journey to the southward from Britain or Japan or Illinois, or any point within the holarctic realm, would show the successive changes in the character of life, though gradual, to be more rapid. The barrier of frost which keeps the fauna of the tropics from encroaching on the northern regions once crossed, we come on the multitude of animals whose life depends on sunshine, the characteristic forms of the neotropical realm.

The neotropical realm includes South America, the West Indies, and the hot coast-lands of Mexico and Central America. To the northward, this realm overlaps the holarctic in the transition regions of Sonora, Arizona, Texas, and Florida; but to the southward the barrier of the broad ocean keeps it practically distinct from all others. The richness of this fauna in forms and species makes the great forests of the Amazon the dream of the naturalist. Joaquin Miller gives a vivid picture of the life of tropical America:

> Birds hung and swung, green-robed and red,
> Or drooped in curved lines dreamily,
> Rainbows reversed from tree to tree,
> Or sang—low hanging overhead,
> Sang soft as if they sang and slept,
> Sang low like some far waterfall,
> And took no note of us at all.

Corresponding to the neotropical realm in position, but with a less rich and varied fauna, is the Ethiopian realm. This includes the greater part of Africa, merging gradually on the north into the holarctic realm, through the transition regions of Barbary, Italy, and Spain. In monkeys, herbivorous mammals, and reptiles, this region is wonderfully rich. In variety of birds and fishes the neotropical region far surpasses it.

The Indian realm comprises southern Asia and the neighboring islands. Its rich fauna has much in common with that of Africa, and it is, moreover, surrounded by transition districts which lead on the north to the holarctic, and on the west to the Ethiopian. On the east the Indian realm is lost in the islands of Polynesia, which represent each one its own degree of transition and isolation.

The Australian realm of Australia and its islands is more isolated than any of the others. It shows a singular development of low types of life, as though in the progress of evolution this continent had been left a whole geological age behind the others. It is certain that, could the closely competing fauna of the holarctic or Indian realms have been able to invade Australia, the dominant mammals and birds of that region would not have been marsupials and parrots. In the words of Prof. Bergen, "the antiquated forms of life are found in abundance only in regions where they

have been long shut off from communication with the great land masses." The rapid multiplication which certain holarctic animals and plants have shown when transported to the Australian realm, demonstrates what might have taken place if impassable barriers had not previously shut them out.

Each of these great realms may be indefinitely subdivided into provinces and sections, for there is no end to the possibility of analysis. No township or school district has exactly the same animals or plants as any other; and, finally, in ultimate analysis no two animals or plants are alike. Modification comes with the growth of each new individual, and steadily increases with the individual's separation in time or space from the parent stock. Moreover, we observe apparent anomalies of distribution in every realm: here appears an animal, there a plant, which seems to have a character or a place which it ought not to hold. To the result of unexpected or chance crossing of barriers these apparent anomalies in geographical distribution are due. Anomalies in distribution, like anomalies in evolution, would cease to be such if we knew all the facts and circumstances of their previous history. The present range of the tapir in Farther India and in the northern part of South America, two widely separated regions, is at first sight an anomaly of distribution. This anomaly disappears when we know that formerly the tapir ranged over the holarctic realm and became gradually extinct with the changing climate. The bones of a tapir, much like one of the South American species, are found in recent clays in Indiana (Ellettsville), and similar remains exist in France, in China, and in Burmah. The isolated, unexterminated colonies are now left at the extremes of the animal's former range, and these colonies at present constitute what we call distinct species.

The more extended are our studies the fewer are the anomalies which arrest our attention, and the fewer are the distinctive or characteristic forms. There is little foundation for the current belief that each species of animal has originated in the area it now occupies, for in many cases our knowledge of paleontology shows the reverse of this to be true. Even more incorrect is the belief that each species occupies the district or the surroundings best fitted for its habitation. This is manifest in the fact of the extraordinary fertility and persistence shown by many kinds of animals and plants in taking possession of new lands, which have become, through the voluntary or involuntary interference of man, open to their invasion. Facts of this sort are the "enormous increase of rabbits and pigs in Australia and New Zealand, of horses and cattle in South America, and of the sparrow in North America, though in none of these cases are the animals natives of the countries in which they thrive so well" (Wallace).

The persistent spreading of European weeds to the exclusion of our native plants is a fact too well known to every farmer in America. The constant movement westward of the white-weed and the Canada thistle marks the steady deterioration of our grass-fields. Especially noteworthy has been this change in Australia and New Zealand. In New Zealand the weeds of Europe, toughened by centuries of struggle, have won an easy victory over the native plants. Edward Wakefield, in his history of New Zealand, says that "many animals and birds acquire peculiarities in the new country which would indeed astonish those accustomed to them in the old. They usually run to a much larger size and breed oftener. They also take to strange kinds of food. Birds deemed granivorous at home become insectivorous here, and *vice versa*. Some learn the habits of the native species. Skylarks imitate the native wagtail, and may often be seen perching on fences and telegraph wires. They sing in the night-time, too, a thing unheard of in the old country, and doubtless acquired from the nocturnal habits of New Zealand birds."

The European house-fly in New Zealand has completely extirpated the large blue-bottle fly which was formerly a source of great annoyance to the settlers. An account is given of a farmer who filled a bottle with house-flies and carried them eighty miles into the country, liberating them one by one, in the vicinity of his sheep-folds, in order to let them take the place of the native flies.

It is said that red clover would not grow in New Zealand until bumble-bees were introduced to fertilize its flowers. Wakefield estimates that the introduction of these large wild bees has been worth five million dollars to the farmers in New Zealand.

Dr. Hooker states that, in New Zealand, "the cow-grass has taken possession of the road-sides; dock and water-cress choke the rivers, the sow-thistle is spread all over the country, growing luxuriantly up to six thousand feet; white clover in the mountain districts displaces the native grasses," and the native (Maori) saying is, "As the white man's rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself" (E. L. Youmans).

As among some characteristic survivals of the Celts in Hampshire, England, Mr. T. W. Shore mentions the round huts of the charcoal-burners, resembling those which were common in the Celtic period; the art of osier-working or basket-making; the mounds on which many ancient churches are built, which were probably sacred sites of those people; and the peculiar orientation of many churches twenty degrees north of east, which is supposed to have been derived from the pagan Celtic reverence for the May-day sunrise.

CONCERNING CORPORATION LAW.

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IF ten Americans desire to engage in ten distinct business enterprises, it is conceivable that they will incorporate ten joint-stock companies, and each belong to all of them. While other countries have granted the privilege of existence to private corporations with extreme caution, if not reluctance, the many Legislatures of the United States have vied with one another in making it easy for them to be born. To adapt words heretofore applied to another matter: "The whole system of the free incorporation of private companies in the United States, with all its excellences and all its defects, is thoroughly characteristic of the American people. It grew up untrammeled by any theory as to how it ought to grow, and developed with mushroom rapidity."

We have no "system" of corporation law in this country; we have, instead, a tangled mass of statutes, which is yet further amended and ensnarled at the recurring sessions of our various Legislatures. We have a still larger mass of judicial decisions, which all the ingenuity and industry of the many writers on the subject can never quite systematize and reduce to order. Even when this feat may be approximately accomplished for a moment, the growth of judge-made law is so rapid that any treatise is speedily out of date. A redeeming feature of the situation is that the mimetic tendencies of our States lead the new ones to follow the examples set by the older, and thus a certain degree of uniformity is introduced into the different codes of law. The many sources of legislation also make it possible that a large amount of experimenting may be done without danger to the country as a whole. The immediate and disastrous consequences of the Granger railroad laws were thus limited to a few States in the Northwest, while their more general influence, as examples of what can but should not be done, has been of use to the whole country. One railroad president has gone so far as to say that in their results these laws have made a solution of the railroad problem possible.

The diversity of regulation has two effects—one commendable, the other not. The first is that when companies do business in all or many of the States at once, and in any line, like that of insurance, where ascertained corporate soundness is the best advertisement, a good code of laws in any one State makes the fact that a company does business there a helpful recommendation. The Massachusetts law regulating insurance is an

example of this. Its stringent requirements do not hamper the companies of that State, but are, on the other hand, an introduction and a guarantee that distinctly aid the Massachusetts companies when they carry their operations into other commonwealths. The same influence is apparently at work in the case of mortgage investment companies; a few of the best established among them priding themselves on complete and ostentatious compliance with the rigid but wise laws regarding publicity of accounts.

The second effect of the diverse rules regarding corporations in the different States operates in an exactly opposite direction. Since it is quite well established that a corporation may incorporate in one State and do all its business in another or others, there is a tendency for dishonest companies to take out charters in that State which bothers them with the fewest restrictions. A charter granted by the Legislature of Pennsylvania incorporating a company to do business in any State except Pennsylvania was held to be void; the Kansas court holding that no interstate comity permitted one commonwealth "to spawn corporations" upon other States which it would not allow to operate within its own borders. But the same thing is accomplished if a State, by a general act, permits companies to organize without specifying the place of business. Under some laws one corporation is not allowed to hold the stock of another; but, on the other hand, there are States that will willingly incorporate a company for the express purpose of holding the stocks of other companies. This is a very convenient fact when a "trust" is to be formed. A State noted for the laxity of its laws in this regard can serve as the birthplace of any number of companies. At present, according to Mr. W. W. Cook, "the snug harbor of roaming and piratical corporations is the little State of West Virginia. Under its laws a corporation may be created for any purpose for which a partnership may be formed, except speculation in land; the capital stock may be five millions of dollars or less; there is no tax except fifty dollars annually; residents or non-residents, aliens or citizens, may be directors; the principal place of business and directors' or stockholders' meetings may be in or out of the State; there is no liability of directors or stockholders except on unpaid subscriptions, and no public reports are required. . . . The incorporation of companies for the purpose of enabling them to do all their business in other States seems to be one of the chief industries of West Virginia." States can only guard themselves against the invasion of hordes of these irresponsible artificial persons by strict statutory regulation of "foreign corporations," but for the most part they have not taken any general precautions of this character.

Besides the defects in the corporation law of the United States which originate in its formless heterogeneity, there are other specific evils quite generally present, which it seems not impossible to lessen. It is the purpose of this paper to present suggestions, drawn from the experience of this and other countries, regarding four points that seem to be of strategic importance in the reform of corporation law:

1. The prevention of "frauds in founding" (*Grundungsschwindeln*). It is a suggestive fact that we have in English no recognized equivalent of the German word here parenthetically introduced. Neither is the English term "promoters" commonly used by American writers. Our examination of the problems of corporate management has been so superficial that we must make or borrow a nomenclature when we wish to discuss the evils connected immediately with the creation of companies. Yet a large portion of the evils connected with the existence of corporations originate at just this point. Men organize companies, at times, for the sole purpose of unloading upon them an unprofitable business. Let the experience of Eastern capitalists with Western mining stocks be put in evidence, and no one will question this statement. Mining companies with a nominal capital of fifty million dollars that have never declared a dividend are not uncommon; and very frequently the stock of mammoth companies sells at one cent on the dollar for some time before it becomes worthless. But the experience in mining is only an extreme case of what takes place in many departments of industry.

In England, turning thither solely because the facts have there been made accessible and have not in this country, it is found that certain men make a business of acting as "promoters." They are skilled in the writing of prospectuses of companies, and know all the arts by which stock can be sold. They devote their energies especially to small companies and small investors. For a time their activity was turned largely to organizing "single-ship companies," the shares of which could be placed among country parsons, serving-women, and other classes of small investors likely to know very little about commerce, and therefore likely to believe anything a well-printed "prospectus" might tell them. Many of these small companies never went so far as to build even a single ship, but enough ships were built by them to materially increase the number of "ocean tramps," and to call for much adverse criticism from the committee appointed "to investigate the loss of life at sea." The "commission appointed to inquire into the depression of trade" also had much to say of the influence of the creation of such great numbers of limited liability companies, of the direct loss to investors, and of the general demoralization of trade resulting from it. In fact, many English

investigators have laid great emphasis on the idea that over-speculation is due largely to the formation of joint-stock companies that have no real excuse for existence except the furtherance of the personal aims of the "promoters." It is a little curious that, among the three hundred real or alleged causes of "hard times," brought to the attention of our National Bureau of Labor, the reckless creation of limited liability concerns was not mentioned. In 1886 a writer estimated that there were afloat in the English stock market fully two billion pounds of speculative securities, of which at least a fourth were mere gambling counters. It is to such a state of things that a recent law review attributes the fact that real investors now shun the stock exchange, and speculative operators are compelled to live on the plan of "dog eat dog."

The stock exchanges of this country have had a somewhat similar experience, and the self-limiting nature of the speculation fever is indicated by the fall in value of a place in the Chicago Stock Exchange of three thousand dollars within a few years. As yet few steps have been taken to restrain the incorporation of absurd or fraudulent companies. Wasteful and semi-piratical paralleling of railroad lines is encouraged; incipient railroads are preyed upon by construction companies; companies of all sorts are bound hand and foot by the contracts entered into by an initial board of directors, and are brought into existence that they may be so bound.

None of the leading commercial countries seem to be quite satisfied with the attempts they have made to remedy such evils as these. Germany allows definite payment from the corporation funds for the trouble and expense properly incurred by the men who organize a joint-stock company, but guards very carefully against the illicit gains too often made by "promoters." The provisions for registering new companies are especially stringent in all cases where a private business or factory is to be sold to a corporation organized to buy and manage it. The fullest possible publicity is sought regarding all the initial acts of a new company, and some matters where the first decision must be final are reserved for a second meeting of the stockholders. Shares may run either to "bearer" or to a particular name. The latter can not be issued for a less amount than fifty *thaler* per share and the former for less than one hundred *thaler* per share. By forbidding the issue of shares of less amount, it is hoped to make investors consider more carefully the subject of investing, and to prevent the floating of small shares in worthless companies among the class of very small investors, who are most likely to be swindled. Some companies designed to engage in what are considered especially hazardous enterprises are forbidden to issue shares of less

than one thousand marks each. The opinion of the United States consul-general at Frankfort-on-the-Main is that all these restrictions have not availed to prevent a regular "incorporation fever," from which he expects very disastrous results ere long.

In France there has been some agitation in favor of returning to the old system in operation till 1863 of "special concessions" by which the right to organize a joint-stock company was a favor granted by the Government, and not a right conferred by general statute. The weight of authority and influence is, however, against this retrograde movement. Leroy-Beaulieu, in considering it, recalls the fact that the prefect of police of Louis Philippe refused Leclaire permission to organize the great profit-sharing company which was afterward established with signal success and which still bears his name. Leroy-Beaulieu adds, "We can bear the guardianship of law, but not of government." Certainly there should be no wish in this country to go back to the old system of special legislative charter, under which men made a business of lobbying for charters which were afterward sold to the highest bidder. One of the things upon which we can especially congratulate ourselves is of having got rid of this old source of legislative corruption, which gave us our wild-cat banks, and numberless other reasons for dreading it.

Our own experience may help us in dealing with frauds in founding if we will stop to consider the difference between the old State banks and our present national banks. The greater security of the latter comes largely from detailed legislation which prescribes the conditions under which artificial persons, designed for the transaction of a given business, will be permitted to be born. What we need at present as regards miscellaneous corporations is fuller knowledge of all the facts connected with their history, and especially of their genesis. Massachusetts is the only State that has collected statistics of private corporations at all comparable with those of the English register of joint-stock companies. Most of the States provide that all new corporations shall register with more or less fullness; but this is either a mere formality negligently performed, or else its sole object is to bring the corporation within reach of the tax-gatherer. The record is usually not published, or in some cases, as in Ohio, there is no way to trace in the published returns the outcome of the enterprises whose beginning is chronicled. In fact, our greatest need in preventing frauds in founding, as in preventing most other evils connected with corporate management, is completer publicity, and, as one result of this, fuller statistical data.

2. The proper regulation of the borrowing power. It has been stated on good authority, but is not true, that the evils of

corporate management of property began when it was found that corporations could borrow. Abuse of the borrowing power is certainly a very common sin among artificial persons, and especially among American railways. When the holders of a small amount of stock, only partially paid in, build a road with borrowed money, the limitation of their liability shields them from personal loss; while their power of voting themselves salaries, and of concluding profitable contracts either with themselves or friends, gives them great opportunities for personal profit irrespective of the success of the road. The last report of the statistician of the Interstate Commerce Commission shows that many of the minor and branch lines of the country have been built wholly with borrowed money —that is, they are bonded to their full cost value. Many of the longer and independent roads are bonded at half to three fourths of their entire capitalization. The total bonded debt of the railroads of the United States is actually greater than the total of their share capital; and this, although the amount of water in the stocks is much larger than in the bonds. As the possession of the majority of the stock gives control over all the capital invested in the roads, it follows, from the figures given in the statistician's report, that the ownership of $1,932,234,128, or 23·77 per cent of the total railway capital, insures complete direction over $8,129,787,731 of railway capital, or 136,883·53 miles of line. Massachusetts law forbids the bonding of a road to an amount exceeding the total of paid-up share capital, and this regulation is being introduced by other States. To forbid the issue of bonds that must be sold below par has been found to limit unsatisfactorily legitimate enterprises, but the effect of such a regulation is thought to be good if applied with care to specific classes of corporations. As to what is best in this matter, as in those that have gone before, we need more definite information.

3. How to secure a more representative and more responsible directorate. In regard to the election of directors it may be said that one device to prevent the tyranny of a majority of the stockholders has been frequently tried, and another frequently recommended. The former plan is to limit the number of votes which any one person may cast. In Massachusetts no person except a municipal corporation can vote over one tenth of the capital stock of a railroad corporation. The trouble with this plan, and the variations of it that have been tried, is that evasion is too easy. Dummy stockholders are very easy to manufacture, and it is difficult to unmask them. The much-recommended device for accomplishing a similar purpose is that of cumulative voting. By this device a shareholder is allowed to cast as many votes for any one director as the number of his shares, multiplied by the number of directors to be elected at the given time. Nebraska has a provision

of this sort in her Constitution, but the domestic corporations in the State have not had a sufficient development to thoroughly test its influence. It will probably do but little good to secure minority representation on the board of directors, unless the laws are so drawn as to limit the tyranny of a majority of the directors. The State of Maryland and the city of Baltimore have derived but scant benefit from their privilege of appointing a minority of the directors of the Baltimore and Ohio Railroad. But if minority representation be backed by the proper legislation governing the actions of the directors, there is no doubt that it is an efficient way of checking the misdeeds of stock majorities.

In Germany there is a second body chosen, under special rules, by the stockholders, known as the board of supervisors (*Aufsichtsrath*). This board has the fullest possible power of investigation and report, but very little power of any other kind. Its usefulness must obviously depend on the rules governing its selection, since, if so chosen as to have interests wholly in common with the directors, it would be of no use as a check upon them.

Turning to the question of responsibility, we find that in this country the principle of limited liability is almost invariably the same for the director as for an ordinary stockholder, though the director is personally liable for all illegal or unauthorized acts. There has been a great deal of agitation of late for the introduction of the French plan of protecting ordinary stockholders by the grant of limited liability, but leaving the directors liable for the corporate debts to the full amount of their respective fortunes. The experience of France with these *sociétés en commandite* has proved that responsible men can be found to manage any legitimate enterprise under this plan. A recent English act permits the formation of such companies in England, but the companies decline to adopt this principle under mere permissive legislation. To make this form of organization mandatory upon certain selected classes of our corporations is an experiment that ought to be tried, and is much better than going back to the old plan of unlimited liability for stockholders, as California has done.

Under the head of the responsibility of the directors must also be treated the question of the relation of the corporation to its employés. Albert Fink one day called together the presidents of certain roads he was trying to organize for their mutual good, and told the gentlemen who responded to his call that he wanted them all to resign. He further explained that this was advisable in order that their general freight agents might thereafter be nominally, as then actually, in charge of the several properties. The Interstate Commerce Association went down very largely because the "gentlemen" who were partners to the agreement could

not or would not control their subordinates. Part of this alleged powerlessness is no doubt assumed that the head may escape responsibility for the action of the members, but part of it is quite certainly genuine. The development in bulk of the ponderous artificial beings has exceeded the development of their nervous systems, and the monsters can only sprawl and plunge instead of going forward to a definite end. This condition, however, is progressively cured by automatic processes. We have as yet no economic treatise on corporation by-laws in general, but well-recognized rules are developing for the organization of specific classes of corporations.

In the narrower view the relation of the corporation to its employés is merely a question of wages, of strikes, and lock-outs, and of relative losses from these disturbances to employers and employed. The statistics of strikes and lock-outs collected by our National Bureau of Labor show that almost the only industry in which the losses inflicted by strikes are heavier on the employers than on the men is that of transportation. The undetermined losses inflicted upon the general public by this class of strikes must be also especially large. Two ways of dealing with these evils have been tried in Europe, either of which seems to be a partial remedy, but neither of which seems likely to commend itself to Americans. The first is to impose a heavy per diem fine or even forfeiture of charter upon any corporation that fails to perform its public functions. This forces the company to make terms of some kind with the strikers. When strikers in this country have tried to secure the forfeiture of charters through the courts, on the ground that the companies did not discharge their public functions, they have met with little success, though in some cases a street-car company has thought it necessary to insist on running a single car each day in order to secure its charter against attack on this ground. The second European method of guarding the public against the loss of strikes is to make it a misdemeanor for any employé to quit work without giving (say) five days' notice. The trial of this method has been advocated in this country, but it may be doubted if our system of police could be relied on to enforce such a law, or if, at the critical time, public opinion would indorse it. That the great corporations see the necessity of acting in the matter, so as to avert the danger that continually hangs over them and the public, is seen in the rapid development of relief associations and other devices for making the position of the employé more stable than it has ever yet been in this country. The President of the Union Pacific Road has advocated the withholding from subordinate officials of the arbitrary power of dismissing the men, the object being to make the men an integral part of the corporation, and to give them security in their posi-

tions during good conduct, and a prospect of promotion if especially efficient. The problems that our Government must confront in the matter of civil-service reform are also to be dealt with by our corporations, and the conditions are enough alike so that the experience of each may serve for the guidance of both.

4. Adequate publicity of corporate transactions. The need of thorough publicity of corporation accounts has been already dwelt on at some length. Nearly all the abuses to which corporate management of property is liable originate and wax mighty only when concealed. On the other hand, secrecy, even when it does not cloak abuses, is commonly suspected of doing so. Most of the unreasoning and unreasonable attacks on corporations have been made when those in charge of the corporations insisted on the privilege of keeping their affairs entirely to themselves. The advantages of business secrecy to the individual business man who practices it are abundantly manifest, but its advantages to the public at large, while also manifest, are countervailed by very serious disadvantages. Experience seems to have demonstrated quite conclusively that a being at once so vulnerable and so powerful as a corporation can not afford to keep its affairs entirely to itself, and if it could afford to do so the public can not afford to let it. There is said to be a strong tendency toward "socialism" in this wresting of business secrets from the great managers of the world's industries, and bringing the most private of business transactions to the bar of public opinion. Many will no doubt answer that "the charge is true, and we glory in its truth." Many more will be inclined to say, with the present writer, that, while this objection should be given its due force, it has not nearly force enough to overrule the strong necessities of the case. The chief danger that legitimate enterprises have to fear from complete publicity is that of overtaxation. The wealth of the corporations lying fully exposed to public view, it is so easy for the politician to fill the public coffers from that source that we already find certain classes of corporations driven out of certain States by excessive taxation. But it may be doubted whether taxation is as likely to be excessive when the state of a company's accounts is definitely known, as when the politician and his constituents are free to draw upon their imaginations for the amount of wealth in the corporate coffers. In other words, it seems probable that in this country, as yet, we have less to fear from willful injustice than from mutual misunderstandings begotten of secrecy on the one hand, and suspicion on the other. European countries are distinctly ahead of us in this matter. They have by no means solved all the problems connected with the corporate management of property, but they have at least collected more of the data that will make a solution possible.

When, in 1873, Adolph Wagner read before the German Verein für Socialpolitik an elaborate paper on joint-stock companies, he made many suggestions as to the reform of corporation law. But he concluded by defending the thesis that, while the reform of corporation law was indispensable, this alone, however perfectly accomplished, could not suffice to eliminate the evils of corporate management of property; he contended that corporations must continue to be mischievous until they are restricted to a narrower field of activity than that now occupied by them; that the state, in its various branches, must assume control of those enterprises that are of necessity monopolies.

To the interminable discussion recalled by the name of Wagner and the mention of his thesis it is here desired to contribute but a single suggestion. Spencer and others dwell always upon the distinction between "compulsory co-operation" through the state, which is said to be characteristic of a "militant *régime*," and "voluntary co-operation" through private associations, which is said to be the proper thing under an "industrial *régime*." Now, is it not true that the distinction between these two kinds of "co-operation" is fading out? Co-operation can be wholly "voluntary" only when isolation is a possible alternative. Is not industrial isolation becoming almost as impossible as political isolation? Co-operation through the state is becoming less and less "compulsory" in the old significance of the term, because it is becoming more and more possible to choose what government we will live under. This comes from increased facilities, both physical and legal, for moving from one state to another. Formerly, a man must obey the state under which he was born; his "co-operation" with it was, indeed, compulsory. Now, expatriation is a comparatively simple and pleasant alternative to obedience. States and nations are coming to compete with each other for desirable citizens, as producers of services or commodities formerly competed with each other for purchasers. There can be no doubt that Bismarck's hand was less heavy upon Germany because so many of her citizens emigrated, and so many more of them might have emigrated to this or other countries. Within the States and cities of our own republic we see our Legislatures and town councils continually coerced by considerations of attracting or retaining desirable classes of citizens. It is easier to escape from the power of the Legislature of Pennsylvania than from the influence of the Pennsylvania Railroad; it is easier to get beyond the reach of the tax-gatherers of all our States than to cease to pay tribute to the Standard Oil Company or to the anthracite coal pool. The point may be restated thus: The "coming servitude" to which we are advancing through the increasing dominance of the state will be modified by the power

of the individual to choose what state he will serve. On the other hand, industrial co-operation, in its broadest sense, is becoming more and more compulsory; the distinction, therefore, between "voluntary" and "involuntary" "co-operation" is of ever-lessening importance.

INSECT PESTS OF THE HOUSE.

By Miss MARGARETTE W. BROOKS.

THE various insects which infest the dwelling have been from time immemorial a trial to careful housekeepers. Just as out of doors the gardener is constantly employed in protecting plants of all kinds from the ravages of insects, so in the house there is a perpetual warfare carried on against these indoor pests. Some eat holes in our clothes, others destroy carpets and hangings, while still others are attracted by the food in our pantries and storerooms.

Unless one has watched the habits of insects and studied their development, it is hard to realize that in their mode of growth they differ from the other animals with which we are familiar. By some it is supposed that an insect grows as a bird or a cat grows —that is, by imperceptible increase in size, with no marked change in form. With this idea it is not strange that a tiny fly should be thought a young fly that will gradually grow bigger, or that a large fly should be supposed to have lived some time to have attained such size. It is a fact fairly well understood that moths and butterflies pass through several changes between the egg and the perfect insect, and that the caterpillar, or worm, as it is more often called, seen feeding in our gardens, or crawling over sidewalks or fences in search of a convenient spot in which to undergo its transformations, will before long assume a totally different appearance; it is not so generally known, however, that in the larger number of insects the change is nearly if not quite as great.

Among the insects which infest our houses we find representatives of most of the various orders of insects, and a study of these forms alone would prove of interest and value. Their habits are well known to the housekeeper, and so in many cases is their appearance in one or more stages; but a history of their life from the egg to the perfect insect is still a mystery to many people, and it is to these that the following pages may be of interest. In this article attention is called only to the more common insect pests of the house.

CLOTHES-MOTH (*Tinea pellionella*).—One of the commonest of

household pests is this little moth. Most housekeepers are familiar with the different stages of its growth, and all are aware of the fact that it is not the little delicate silvery moth that does the damage, except indirectly by laying its eggs in our woolen garments.

The moth, measuring less than half an inch across its spread wings, easily makes its way through the smallest crevices, and unless care is taken in the spring and summer we may find garments that have been carefully laid away in boxes and drawers, as well as clothes hanging in closets, are infested by this creature. As a general rule, the worm seems to prefer partially worn and soiled garments to new cloth.

d *c* *b* *a*

FIG. 1.—CLOTHES-MOTH. *a*, the moth (natural size); *b*, larva; *c*, case; *d*, pupa (*b*, *c*, and *d* are enlarged).*

Early in the spring garments should be well beaten and brushed to dislodge the moths or any eggs that may have been deposited in the folds of the cloth, and then hung in the air and sun for a while.

When possible, garments should be folded in paper, leaving no chance for the moth to enter; large paper bags being convenient for this purpose. Camphor-wood or red-cedar chests are valuable in protecting articles which can not easily be wrapped in paper, as the odor of these woods is disagreeable to the moth; and when these are not to be had, oil of cedar poured on paper, which is then rolled up so that the oil shall not grease the garments, will make an ordinary box moth-proof. These rolls of paper should be scattered through the box and should be renewed two or three times during the spring and summer. It is said that black pepper or whole cloves sprinkled among woolen clothes will prevent the moth from depositing its eggs, as will also pieces of tallow wrapped in paper, and the odor of carbolic acid, turpentine, or benzine is very offensive to the moth. Camphor, as is well known, is beneficial in keeping away moths, but should never be placed near seal-skin, as it causes this fur to change color, showing streaks of gray or yellow. The great secret in taking care of furs is said to be frequent and thorough beating, the furs being kept in close closets lined with tar-paper.

It has been said that the odor of tobacco is disagreeable, but in the experience of some it has seemed rather to attract than to re-

* Figs. 1, 5, and 6 are from Our Common Insects, by Prof. A. S. Packard, and we are indebted to the kindness of the author for permission to use them.

pel the moths. In more than one case it was found that clothes belonging to men using no tobacco were free from the attacks of moths, while in the pockets of those who smoked constantly were found both eggs and larvæ mixed with bits of tobacco, the garments having been eaten in various places. Of course, this is not an absolute proof of the inefficacy of tobacco, as there may have been other causes of attraction, and fresh, clean tobacco may, after all, be found effectual.

The larvæ or the eggs can be killed by putting the article in which they are found in a tightly closed vessel, and plunging it for a short time into boiling water, or it can be placed in an oven heated to a temperature of 150° Fahr.

It is hardly necessary to describe the moth, which, although so small, is easily recognized as an enemy by most housewives, though in many cases little moths of various species attracted to our rooms by the lamp-light in the evening are often mistaken for the clothes-moth and destroyed. It may be well to state that the clothes-moth rarely flits about the light.

Soon after the moth issues from the cocoon the female finds its way to the substance suitable for food for its young, and upon this material it lays fifty or more eggs. In about a week the egg is hatched, and almost immediately the worm begins to eat, and not only uses for food the fibers of the article upon which the egg was laid, but also makes of the material a covering for itself—a little tube in which it lives, spinning for a lining the softest silk, which it emits from glands in the head. From time to time, as the little worm grows, it enlarges its case, either by adding to the ends or by cutting with its sharp jaws little slits in the sides of the case, filling in the space between the edges with the substance nearest at hand, forming a neat patch. Not content with eating and making a shelter for itself of the cloth upon which it lives, the little worm cuts through the cloth as it makes its way in various directions, dragging its case after it. If the case is torn from it, or in any way injured, it soon makes a new one or patches the old. After a while, at the approach of warm weather, the little worm closes the ends of its case and changes to a pupa or chrysalis, and in two or three weeks the moth appears.

BUFFALO-BUG (*Anthrenus scrophulariæ*).—Within fifteen or twenty years there has appeared a new addition to the already long list of injurious insects introduced into this country from Europe. Although called a bug, which is the name commonly applied to all insects having inconspicuous wings, it is in reality a beetle, and why the name buffalo is applied is not known for a certainty; some say it was first noticed in this country in the city of Buffalo, New York, while one writer says it was named from its fancied resemblance to a buffalo. Whatever may be the

reason for this name, and however inapt it may be, it is known more commonly by it than by its more proper name of "carpet-beetle."

The larva which does the damage measures when full grown about three sixteenths of an inch in length. It is covered with hairs, the longest ones being on the last segment of the body, forming a sort of tail. It makes no cocoon, but when full grown remains quiet for a short time, then the skin splits along the back

FIG. 2.—CARPET-BEETLE. *a*, larva, upper side; *b*, larva, under side; *c*, pupa; *d*, perfect insect (after Riley). The straight lines at the sides show the actual length of each form.

and the pupa is seen. It continues in this state for a few weeks, when the skin of the pupa bursts and the perfect insect is disclosed—a beautiful little beetle, less than an eighth of an inch in length, marked with red, black, and white. From October until spring the beetles may be found in all stages of growth—that is to say, in the larval, pupal, and perfect states.

It is found that few of the usual preventives are of any use against the attacks of this beetle, and for this reason it is a difficult pest to eradicate. In some places it has proved so destructive that carpets have to be dispensed with, and in their place rugs are used, as being more conveniently examined.

Tallow or tallowed paper placed around the edges of the carpet, which are often the parts first attacked, is said to be effectual. In many cases the carpets are cut, as if with scissors, following the line of the seams in the floor, and as a remedy for this it has been recommended that the seams be filled during the winter with cotton saturated with benzine. Kerosene, naphtha, or gasoline are offensive to the beetle as well as benzine, but benzine is perhaps the simplest and safest preventive to use. It can be poured from a tin can having a very small spout, it being necessary to use but little.

Before tacking down a carpet it should be thoroughly examined, and if possible steamed. If in spite of precautions a car-

pet is found infested, a wet cloth can be spread down along the edges, and a hot iron passed over it, the steam thus generated not only killing the beetles and larvæ, but destroying any eggs that may have been laid. Clothing is sometimes attacked as well as objects of natural history—such as stuffed birds and mammals.

It was believed that the beetle must feed on some plant, for in a number of cases it was captured out of doors, and it was finally discovered feeding on the pollen of the flowers of spiræas, the beetle living on the plant for a while and then returning to the house to lay its eggs. When this was proved, it was suggested that spiræas should be planted around houses infested by the beetle; by doing this the plants could be often examined and the beetles destroyed.

COCKROACHES (*Blattidæ*).—Among the *Orthoptera*, to which order this family belongs, we find a different mode of transformation. Were it not for its small size and the absence of wings, the young would closely resemble the parent, and, after molting or changing its skin several times, it reaches maturity without having passed through a stage in which it keeps perfectly quiet, as in the case of the moth and beetle.

FIG. 3.—COCKROACH. *a*, male; *b*, female.

The eggs of the cockroach are carried about in a little case by the female, and when these eggs are ready to hatch, this case is dropped; and it is said by some writers that the little ones are helped out by the mother. Just after the young come from the egg, and after each molt, they are white, but the usual color is brown or black. They molt five or six times before reaching maturity.

Cockroaches are very troublesome, eating anything that comes in their way; are unpleasant to look upon, and are specially disgusting to us on account of their disagreeable odor.

The large cockroach (*Periplaneta orientalis*), or "black beetle," as it is sometimes called, might in some cases be not unwelcome, as it acts as a scavenger, keeping the corners of the rooms it frequents clean, and furthermore it feeds on that most disgusting of pests, the bed-bug. Though this is said in its favor, we think there is no doubt that the remedy might be thought as bad as the disease, and it would be considered more agreeable to find some other way of exterminating the bed-bug; and most people would

prefer having their corners cleaned in the ordinary way, with soap and water; nevertheless, it is sometimes of service in this way. This cockroach is of a dark-brown color, about an inch in length; the male having short wings, while the female has only rudimentary wings. It is very troublesome in kitchens, coming out at night when the lights are out.

A somewhat larger insect is the American cockroach (*Periplaneta americana*), which is a lighter brown color, both the male and female having well-developed wings. This species is not so often found in houses, but frequents water-pipes and sewers and the cargoes of vessels.

The smallest cockroach which is a pest in our houses is the "water-bug" (*Ectobia lapponica*). It is also known as the "Croton-bug." This insect is very common in houses in New England, and, though eating any kind of food, is especially fond of bread. It frequents bakeries, where it proves a great annoyance, sometimes being baked in the bread in spite of care. It also eats the covers of books bound in cloth, but will not touch those bound in leather.

It has been said that sailors have been greatly troubled by cockroaches eating the nails of their fingers and toes, and the hard parts of their feet and hands, but this has been questioned. However, a writer in Nature affirms that while in Australia he was awakened one night by cockroaches nibbling his feet, which were badly blistered, and in the morning he found the skin had been eaten from a large blister, causing a painful sore, and that the hard skin of the heel had also been eaten. Another writer in the same journal says that this habit of cockroaches is well known to all West Indians.

Borax is very disagreeable to cockroaches and will drive them away, and it is said to kill them if mixed with white sugar and sprinkled around the corners frequented by them. The following receipt for a preparation to exterminate cockroaches is given in a late number of Science: thirty-seven parts of borax, nine parts of starch, and four parts of cocoa. This preparation should be sprinkled around their haunts.

Insect-powder does not kill them but renders them stupid, and while in this condition they can easily be swept up and destroyed. In England cockroaches are sometimes caught with stale beer, which is placed in a deep dish, bits of wood being so arranged that the cockroaches can climb into the liquid. The following preparations are mentioned in Harris's Insects Injurious to Vegetation, but, as they are poisonous, they should be used with the greatest care. The first is a tablespoonful of red lead and Indian meal, mixed with enough molasses to make a thick batter; the other is a teaspoonful of powdered arsenic mixed with a table-

spoonful of mashed potatoes. These preparations should be used for several nights in succession.

BRISTLE-TAIL OR SILVER-FISH (*Lepisma*).—Often when looking into a box or drawer which has remained in a damp place for some time, or on opening an old book, we see a curious little silvery creature running swiftly out of sight. It is so unlike the insects which we usually find in our houses that one hardly knows what to call it. It is nevertheless an insect, though belonging to a low order. Its long, slender body is covered with delicate iridescent scales, from which is derived its name "silver-fish"; it has no wings and passes through no metamorphoses. It feeds on silken clothing, tapestry, and the like, but is more destructive to books, eating the paste of the binding and even the leaves, though loose papers are more often attacked. A few years ago one species was found doing a great deal of damage in museums by eating the labels. The labels which were rendered illegible by the attacks of this insect were made of heavily sized paper, in most cases common unglazed paper remaining untouched by them; and it was also found that only clothing finished with starch or sizing was subject to their attacks. Prof. Hagen, writing on this pest, recommends that insect-powder, which easily kills them, should be sprinkled about silk dresses or any articles liable to be injured by them. Where papers are pressed close together the *Lepisma* can do no damage; but in cases where pressure might injure the papers or pictures they might be inclosed in boxes, taking care that the covers fit so closely that no space is left for the insect to enter, or the boxes might be sealed up by pasting strips of paper around the covers, a paste with which insect-powder has been mixed being used for this purpose; valuable framed engravings might be covered on the backs with common paper, the same kind of paste being used. There is no doubt that labels washed in an alcoholic solution of corrosive sublimate would be rendered proof against the attacks of this insect.

DEATH-WATCH (*Anobium*).—Books are also eaten by the larva and the mature insect of several species of beetles belonging to the genus *Anobium*. These beetles produce the ticking sound sometimes heard in the wood-work of houses, specially noticeable at night, when everything is quiet. This sound is probably a sexual call, and is made by the beetle rapping the wood with its head. Injury is also done by them to furniture and food, and they sometimes prove a great annoyance. Their depredations may be prevented by washing articles liable to be attacked in a solution of corrosive sublimate in alcohol, or objects such as books may be exposed to the odor of carbolic acid or benzine, or they may be fumigated with burning sulphur.

There are still other insects which do more or less damage in

libraries* by eating the books, but those already mentioned are the principal ones.

ANTS (*Formicidæ*).—Of the large black or brownish ants that trouble us in store-rooms but little can be said, as, so far as I have examined the authorities within my reach, I have found but little mention of them. Judging by my own experience, they are very difficult pests to expel from the house. Cayenne pepper is said to be disagreeable to them, and arsenic mixed with any kind of attractive food will kill them. Oil of peppermint is found very effectual in driving them away, but everything in its vicinity is so permeated with the odor that its use can not be recommended. It is often said that borax will drive them away, but this has been tried without success; however, according to a writer in the Popular Science News, the borax should first be heated, to deprive it of its water of crystallization. Hot alum-water is very offensive to most of the insect pests of the house, and should be applied with a brush when nearly boiling hot.

Ants are extremely fond of sugar, and anything containing it will attract them. A glass of jelly left uncovered within their reach will be found tunneled in every direction, and, by pouring boiling water upon it, the ants within may be killed.

An excellent and simple trap for them is a sponge wet with some sweet sirup. When the interstices of the sponge are filled with the ants, it can be carefully taken up and plunged into boiling water, and again set for them after saturating the sponge with the sirup.

Another trap which is still more simple is a plate covered with a thin layer of lard, which should be placed in the closet frequented by them. This would probably prove more effectual in catching the little yellow ant (*Myrmica molesta*), which is sometimes very troublesome in the house.

Mention should be made of the white ants, which, although resembling the true ants in appearance, really belong to the order of *Neuroptera*. The only species found in the United States does great damage by eating the interior of the wood-work of buildings. These ants enter the timbers of the foundation from below, and extend their galleries to the top, leaving the outside untouched, so that their presence is unsuspected until the supports suddenly give way.

Several years ago the "dungeon," as it is called in the State-House in Boston, was found to be undermined by them, and Dr. Hagen apprehended considerable trouble if their depredations

* Prof. Verrill found in the library of Yale College a caterpillar belonging to the genus *Anglossa* eating the leather bindings of old books. When ready to transform, this larva spins a silken cocoon, and after a short time there issues from it a little moth measuring half an inch across its spread wings.

were not immediately checked. In addition to the danger of the supports giving way, there was reason for alarm in the fact that they also destroy books and paper; but in this case, fortunately, the papers stored in the part of the State-House in which they appeared were of little value. Measures were taken at the time to prevent their devastating work, and it is hoped that they have been exterminated; but Dr. Hagen, in an article on the subject a few years later, thought it not improbable that they had spread farther, as nothing was done to prevent their entering other parts of the building.

These ants feed on rotten wood, living in old stumps of trees, and sometimes in old fences, and Dr. Hagen suggested the removing of every old stump around buildings and in the vicinity of cities, thus diminishing the number by depriving them of their necessary food. Places kept moist by hot steam are particularly favorable for the work of these little creatures; and more or less trouble was occasioned in Cambridgeport, at the telescope works of Alvan Clark and Son, where a timber constantly moist from the steam was honey-combed by them; and some years ago a bridge near Porter's Station in Cambridge was destroyed, probably from the same cause. As many trains stopped under this bridge, it was constantly moist from the steam of the locomotives.

So far the insects mentioned are those that do direct injury to our clothes, carpets,* food, books, etc., but there are still others which frequent our houses and prove very annoying in various ways; and besides these there are numerous insects which cause much trouble in collections of natural history, and in museums the utmost care must be exercised to prevent their attacks. It is not often that these museum pests prove of much annoyance in the house. I have found the larva of a beetle (*Attagenus pellio*) in the sawdust of a doll's arm; and the larva of another species (*Attagenus megatama*) is sometimes found to have eaten the feathers in pillows, and the short particles of the feathers become so firmly fastened in the ticking by the repeated shakings of the pillow that a fine, soft felting is made, resembling the fur of a mole.

Bed-Bug (*Cimex lectularius*).—The eggs of the bed-bug are white in color and oval in shape. The young differ but slightly from the parent. The full-grown bug is wingless or possesses rudimentary wings, is less than a quarter of an inch in length and of a brown color. It is about eleven weeks in attaining its

* A brief mention may be made of a fly (*Scenopinus pallipes*) whose habits are but little known. The larva is a long, white worm living under carpets, upon which it is supposed to feed, and it is also found in rotten wood, but as yet it has not appeared in numbers sufficiently large to prove an annoyance in the house. The full-grown fly measures about a quarter of an inch in length.

growth. Dr. Packard, in his Guide to the Study of Insects, says that bed-bugs may be destroyed by "a preparation consisting of thirty parts of unpurified, cheap petroleum, mixed with a thousand parts of water"; and in the Popular Science News was published the following formula for a bed-bug poison: Into one half pint of alcohol put one ounce of camphor, with one ounce of pulverized sal ammoniac and one ounce of corrosive sublimate; to this add one half pint of spirits of turpentine and shake well before using. These solutions may be applied around the cracks and crevices of a bedstead; benzine, too, may be used with good effect, and boiling water will destroy them, but the best preventive is perfect cleanliness. Curiously enough, they live parasitic upon domestic birds.

FIG. 4.—BED-BUG. *a*, young; *b*, adult (after Riley), both enlarged.

FLEA (*Pulex canis*).—The fleas, although having no wings, have until lately been classed with the flies (*Diptera*), but are now placed by many writers in an order by themselves, the *Aphaniptera*. During the past summer and fall there has been considerable annoyance caused in and around Boston by this troublesome insect, and owing to its habit of attacking man it was supposed to be the true human flea, but a letter of inquiry on the subject, addressed to an eminent entomologist brought the following reply: "So far as I know, we do not have the human flea in North America, and ours is *Pulex canis*, the dog and cat flea. It seems to breed in sandy cellars and such places at certain seasons."

FIG. 5.—FLEA (much enlarged).

The eggs of this flea are laid on the dog or cat, and, being sticky, adhere to the hair until almost ready to hatch, when they fall to the ground. These eggs are very small, white, and oblong, and but eight or ten are laid by one female.

The young larvæ are hatched in about a week, and their growth

is usually attained in less than two weeks; they then pass two more weeks in the pupal stage, when the perfect insect appears. When dogs are badly infested by them, the use of common olive-oil is recommended. This should be well rubbed into the hair and over the skin, being allowed to remain for half an hour, when it should be washed out with the best yellow soap and lukewarm water. Dalmatian insect-powder has also been found efficacious. This powder can be rubbed into the hair, and it can be sprinkled around their kennels. It is not, however, best to use it on cats, but possibly it might do no harm to sprinkle it around their sleeping-places. A better plan is to have the cat's bed made of shavings or some such material that can often be replaced, the old bedding being carefully taken up and burned.

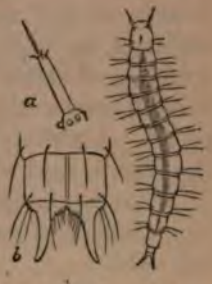

FIG. 6.—LARVA OF FLEA.

Some years ago there were on exhibition a number of so-called educated fleas, and it is thought by some people that the intelligence of fleas must be very great if they can be trained in this way; but an article by Mr. W. H. Dall, in the American Naturalist, a few years ago, showed that in every case the motions made by the flea were caused, not by the training it had received, but by the struggles made in its efforts to escape.

HOUSE-FLY (*Musca domestica*).—Familiar as we all are with this insect in its mature state, it will be found that to many its history before it appears in our houses is still very obscure, and until some years ago, when Dr. Packard made a study of its life-history, naturalists, too, were somewhat unfamiliar with its early stages of growth, and to him we are indebted for the following facts:

We find the flies most annoying and abundant in the hot dog-days of August, and, unless the greatest care is taken, our rooms are filled with them, even though we may be some distance from a stable, where the desired food for the young is found. The eggs are laid in bunches in manure, often buried out of sight, and, the conditions being favorable, they are hatched in twenty-four hours. The worm or maggot has no legs, and, after changing its skin, appears larger, though otherwise remains about the same in appearance. After two or three days it again sheds its skin, and in this stage of development it remains two or three days longer. It then transforms into a chrysalis, in which state the body contracts somewhat and becomes brown and hard, and, after six or seven days, the perfect fly appears and lives for five or six weeks, perhaps longer. A few flies probably live over the winter in crevices of buildings until the warm spring days bring them out.

[illegible]

[illegible] the dry mud
[illegible] the [illegible] and twenty

[illegible] of [illegible] in the [illegible] of alter-
[illegible] [illegible] [illegible] making them:
[illegible] [illegible] [illegible] [illegible] grow-
[illegible] [illegible] [illegible] [illegible] being the

[illegible] [illegible] [illegible] [illegible] meth-
[illegible] [illegible] [illegible] [

tried. Still other washes are made, some of which may be found a protection. A number of rules are given in The Popular Science News during the year 1882. The house can be kept tolerably free from mosquitoes by using care, and a netting over the bed protects one during the night; but, when one wishes to spend his summer vacation in the country, he is willing to try anything that will protect him from these most annoying creatures, which make a morning spent in the woods a torture instead of a pleasure.

APPARATUS-MAKING IN EDUCATION.

By M. C. WILSON,
PROFESSOR OF NATURAL SCIENCES, ALABAMA STATE NORMAL SCHOOL.

BY way of further illustrating the truth of what Prof. Woodhull says in his article, Home-made Apparatus, in the August, 1889, number of The Popular Science Monthly, allow me to present some work that has been done here in that direction.

We have no workshop and no tools. Our method of work is this: In the study of natural philosophy, when a principle is being enunciated, some half-dozen or more members of the class are asked to make the piece of apparatus which illustrates this principle. A week is allowed for its completion, or a longer time, if the work involves much difficulty, or if the pupil has much work in other classes. He is allowed to use any material he can get, and he may ask the aid of a blacksmith, carpenter, or any mechanic. But the work, when brought in, must be neatly finished, and must be made of materials that cost absolutely nothing. Of the six or more pieces of the same kind, the neatest and most accurate one is preserved in school. In this way, in the course of time, some hundreds of pieces of apparatus are made which serve perfectly well to illustrate the principles of natural philosophy. These pieces are handled, tested, and compared by the pupils in the class-rooms, and in this way they voluntarily spend spare minutes before and after school hours. They consist of such articles as inertia apparatus, steelyard, balance of equal arms, pulleys, inclined planes, wheel and axle, hydrometer, siphon, fountains, Leyden jar, pith-ball electroscope, gold-leaf electroscope, batteries of various kinds, magnets, electro-magnets, telegraph apparatus, etc. These, if purchased from an instrument dealer, would amount to several hundred dollars.

For materials for construction of apparatus, the pupils ask at home or at stores or shops where they are acquainted. There are always bottles, tin-foil, corks, wax, wood, scraps of wire, iron, tinplate, bits of thread, cloth, etc., to be had for the asking. Almost

every kind of business in some way contributes its share. There is no difficulty whatever in getting these things, for the merchants and mechanics are usually pleased when the boys ask for them.

One of the pieces of apparatus made in class was a steelyard, which was constructed of a foot-rule. Exactly one inch from the end a hole was bored; through this a wire was passed and bent into a loop. This served for the pivot. Three fourths of an inch from the same end another wire, similarly bent and inserted, served for the suspension of the weight. The pea was made of a small piece of pig-iron picked up at the furnace. It was carefully weighed, and had a small cord tied around it so that it could be slid along the beam of the steelyard. This apparatus was made to illustrate the lever of the first order, and when tested weighed as accurately as the grocer's scales.

Another piece was a balance of equal arms, which was sensitive to five milligrammes, either loaded or empty. It is represented in Fig. 1. The beam, support, pointer, and index were cut out of wood. The scale-pans were tin-box tops. The knife-edges

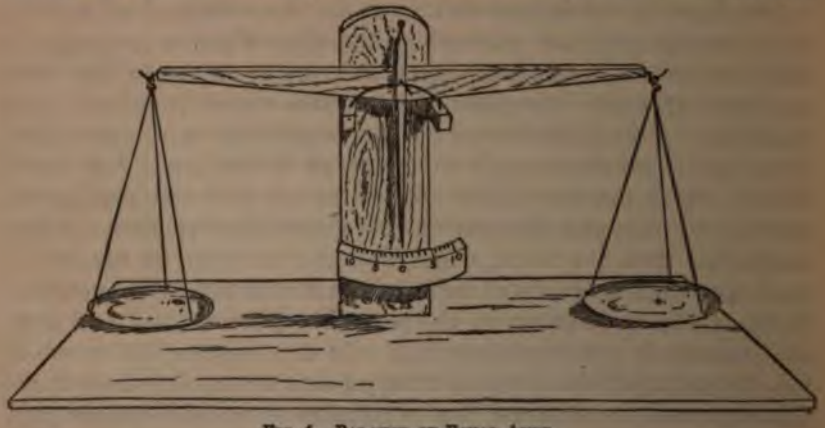

FIG. 1.—BALANCE OF EQUAL ARMS.

were made of old umbrella wire tempered hard. The weights, from ten grammes to five milligrammes, were made of pieces of copper wire. In making this balance, the pupil had his attention forcibly called, by repeated failures, to the necessity of having the arms exactly equal, to the best position of the center of gravity of the balance, and to the importance of the knife-edges. This balance—the best of four brought in—was used to determine the specific gravities of minerals, and the results obtained agreed closely with those given in Dana's Manual. It was also used in the candle experiment to show that there is gain in weight when a candle burns, and for numerous other experiments.

A hydrometer, made by another boy in the same class, accord-

to a suggestion found in Gage's Elements of Physics, illus-
d well the advantage of requiring pupils to make apparatus,
when free access is had to that made by the instrument-
er. A piece of wood cut from the spoke of an old wheel was
ed at one end with lead, so as to make it stand upright. It
immersed in rain-water, and the water-level on it marked
. By means of a Baumé's hydrometer the level of 900 was
d, and distances, equal to the distance between the two marks,
off above and below. Much to the boy's surprise, the hy-
neter thus graduated would by no means coincide with his
mé. He attributed the error to the absorp-
of the fluids by the wood, and set to work
ake another, taking care this time to rub the
i with beeswax, to render it impervious to
ds; but his second graduation was hardly
e satisfactory than the first. He then put
piece of cork for a float, the wood having
d to keep an upright position in all liquids,
graduated his hydrometer by means of dif-
nt liquids whose densities had been found
the Baumé hydrometer, and at last discov-
that the divisions were not equal. This piece
ork, represented in Fig. 2, consumed all the
s afternoons for a week; but I saw the effect
in increased carefulness, and consequently
ter accuracy in his subsequent work, and,
t was still more important, in increased
ghtfulness.

FIG. 2.—HYDROMETER.

condenser for use in distilling water was
e after the pattern of Liebig's. The outside
was made by boring a round piece of wood,
inches long and two inches in diameter,
ugh with an inch auger. The inside tube,
those for entrance of cold water and exit of
water, were made of reeds. A bottle served
the still, and the whole was supported on a
wooden stand.

uch work undoubtedly requires much energy
he part of the teacher, for his suggestions
be needed and asked for many times during
week. But if he is a mere college or high-
ol graduate who has gained his knowledge of science from
lectures and experiments of the professor, he will find this
k of making home-made apparatus even more beneficial to
self than it is to the pupils. He will by means of it have
h light thrown upon obscure places, and will accordingly

teach more effectively. He will become so familiar with his work that he will find himself being transformed from a mere hearer of lessons from the book into an enthusiastic co-worker with his pupils.

WHY SO MANY DEFINITIONS OF RELIGION?

By FRANK N. RIALE, Ph. D.

RELIGION is now recognized, as never before, to be a universal factor in race development. "Whether we descend into the lowest roots of our intellectual growth, or ascend to the loftiest heights of modern speculation, everywhere we find religion a power that conquers even those who think they have conquered it." This fact is to the scientific student of religious thought what the "*cogito ergo sum*" was to Descartes, and what "justification by faith" was to Luther—the foundation on which all must rest, and the unquestioned presupposition from which he must start. It is certainly the fact that can not be doubted, and the one which no *aqua regia* of thought will dissolve.

But there are about as many definitions of religion as there are forms of religious belief. Herbert Spencer defines it as "an *a priori* theory of the universe." Matthew Arnold says it is "ethics heightened and lit up by emotion; or, more simply stated, morality touched by emotion." Max Müller seemingly differs widely from both, and calls it "the sense of dependence on something or some one not ourselves"; while Schleiermacher carries the idea still further and says, "It is a feeling of *absolute* dependence on something which, though it determine us, we can in no sense determine." Feuerbach makes religion "a mere covetousness, which manifests itself in prayer, sacrifice, and faith." Strauss combines the elements brought out in the last two definitions, and describes it as a "combination of absolute dependence and covetousness." To Hegel, the great genius of German thought, "religion is perfect freedom, for it is nothing more nor less than the Divine Spirit becoming conscious of Himself through the finite spirit." Very similar to this are the definitions of Luthardt and Martineau. The former says, "Religion is the human mind standing in reverence and inspiration before the infinite energy of the universe, asking to be lifted up into it, opening itself to inspiration"; while the latter expresses nearly the same idea, though more tersely, "Religion is mere assent through the conscience to God." Mr. Andrew Lang says: "Religion may be defined as the conception of divine or at least superhuman powers, entertained by men in moments of gratitude, need, or distress; when, as Homer says, 'all folk yearn after the gods.'" Flint, in

his Theism, regards it as a "belief in some god or powers above on which we depend, and who are interested in us; together with the feelings and practices resulting from such belief." Somewhat like this, but more explicit, is Prof. Whitney's definition, "A belief in a supernatural being or beings, whose actions are seen in the works of creation, and of such relation on the part of man toward this being or beings as to prompt the believer to acts of propitiation and worship, and to the regulation of conduct." De Pressensé thinks "true religion has to do with the relation of the soul to God," and Prof. Palmer sums it all up as "the bond between the science of ethics and the science of theology."

Many more definitions might be given, but let these few suffice; for they are typical of some sixty or more that have been examined. One is at once led to ask, Why are there so many definitions of a fact that is so universally admitted to be as real as any fact in the realm of mind or heart? Although the definitions are many, they can not be said to be contradictory or antagonistic. When carefully examined, it will be found that they each describe what their respective authors, either from personal experience or observation, thought was the controlling element exhibited at the moment of religious awakening. They are many, simply because the element exhibited then is not the same with all, but varies most markedly with environment, temperament, and general intellectual advancement.

It is now admitted that the religious element, if it appears at all, is called forth while one is reflecting on his personal destiny. There is then born a conviction that our future existence is not unalterably fixed, as that of the stone and the brute, but depends largely on our will. We feel that *ideals* have a large part to play in determining our future condition, and we desire to select such material out of all our environment—yes, *ought* to select such—to weave as a woof into the web of hereditary tendency, as will make for us characters most nearly like unto the pattern given in our ideal. In brief, it may be said that the religious element of the life is called out the moment one earnestly asks the question, "What must I do to be saved"—reach my ideal? That it does ever appear at this moment seems now to be a necessary conclusion from psychical study, a most careful examination of the marked religious awakenings in our own and other religious systems, from a study of the world's great religious leaders, and last of all, by a study of the varying element in the historic changes of religious thought. More than simply an enumeration of these lines of evidence can not be here given. Admitting this to be a fact, the reason why there are so many definitions will at once be perfectly clear; for it will be found they each describe what

was thought to be the essential thing for the attainment of the great idea.

A brief examination of a few of the definitions just given will make this clear. When one of a pre-eminently scientific cast of mind comes, in self-reflection, to the moment of religious awakening, he at once desires to *know* more of self and environment, that he may act with greater certainty in determining his destiny. He feels destiny depends primarily on *knowledge*, and to him religion most naturally seems what it does to Herbert Spencer, "an *a priori* theory of the universe." To those who feel, *activity* based on knowledge is the all-important thing. Prof. Palmer's definition better expresses the essential element—"the connecting link between the science of ethics and the science of theology"—the former giving a knowledge of one's relation to his fellows, the latter of his relation to the gods, religion being the dynamic called forth by this twofold knowledge of personal duty. There are others, again, decidedly social in their make-up. Their chief delight is in pleasant mingling with their fellows. These, on becoming conscious that they are the molders of their own destiny, feel at once that their "salvation" depends largely on a "good-will to mankind," with the acts that result therefrom. All such can truly say, with Arnold, that their religious life is "ethics touched by emotion." There is another class in the social organism of a clinging, dependent disposition, always followers and never leaders in life. These generally become so overwhelmed at the thought of their own responsibility that they lose all confidence in their own ability to choose out their own way, and at once throw themselves helpless on "the powers that be." Fate, or God, or universe, or anything, they would sooner rely upon than their own judgment. To these religion is what Müller found it, "a feeling of dependence on some one or something not ourselves." Extreme cases are better described by Schleiermacher—"absolute dependence on something which determines us, but which we can in no sense determine" (affect).

In marked contrast to the cases already named there are those whose lives are a perfect quintessence of egoism and selfishness. To these religion is always a "mere covetousness, which manifests itself in prayers, sacrifices, and faith." All such make Feuerbach's creed theirs too, "Mann ist was er isst." A higher type of religion than has been thus far named is that which feels "there is a divinity within us that shapes our ends," and that we are all "sons of the Highest." Such care not for self alone, but ever desire to become more and more altruistic. They study the microcosm only to more fully understand its functional place in the macrocosm. These, upon the religious awakening, have the egoistic thoughts thrust aside like the drift-wood by the sea, feeling that

they are only a hindrance to the attainment of the God-consciousness. Hegel-like, they find that "religion is a perfect freedom, for it is nothing more or less than the Divine Spirit becoming conscious of itself through the finite spirit." They can also say, with Martineau, it is "the human mind standing in reverence and inspiration before the Infinite Energy of the universe, asking to be lifted into it," or "ascent through the conscience to God." Religion to them is the last step of the Leibnitz's monad coming into the consciousness of the divinity ever potentially present.

Besides the types of minds thus far studied, there is a large proportion of the race influenced almost entirely by what may be called personal influences—love, pity, sympathy, and the like. All these, upon becoming religious, at once bestow similar feelings on the gods, and imagine that these in turn bestow the same on them. This mode of religious awakening is almost a universal one in the earlier stages of race development. Many also feel, as Mr. Martineau says in his Study of Religion, that in some form or other this will be likewise the final and highest stage of religious growth. It is well described by both Profs. Flint and Whitney, as noted above, and is also implied in the terse expression of De Pressensé, "Religion is the relation of the soul to God."

Thus it will be seen that the various definitions of religion are but facets of a common precious truth, reflecting at different angles the light of a heart all aglow with the thought of personal responsibility in individual destiny. They vary at times so as to indicate almost generic differences, but they all describe facts having a common psychological cause and point to a single purpose. As the same sunlight that hardens the bricks in the cathedral walls also melts the waxen taper at the altar, so a reflection on personal destiny often calls forth in one a religious life entirely different from that in another; for the precise effect depends as much on surroundings and internal difference as on that which calls forth the religious life. These definitions are not found to be like the Ptolemaic planets, mere lawless wanderers, in the realm of religious thought, but have a common center, and are guided by a universal law.

Mr. John Aitkins's later observations on the number of dust-particles in the atmosphere show that a very large proportion of the pollution caused thereby is the product of human agencies. Both dust and humidity tend to decrease the transparency of the air. Humidity alone seems to have no influence on the transparency apart from the dust, but it increases the effect of dust by increasing the size of the particles. Its modifying effect is influenced by the temperature. Dust appears to condense vapor long before the air is cooled to the dew-point. Haze is shown in many cases to be simply dust, on which there seems to be always more or less moisture. All the fogs tested contained much dust.

THE MUSICAL SENSE IN ANIMALS AND MEN.*

By AUGUST WEISMANN.

THE author, having argued at length that the development of the musical sense is not a result of sexual selection; that it is not a faculty essential to the preservation of the race; and that, as it exists naturally in individuals previous to being cultivated, it is not a faculty that grows with the growth of the race—seeks an explanation of its existence in regarding it as simply a by-product of our organs of hearing. These organs, he goes on to say, are necessary in the struggle for existence, and may therefore have originated and been developed to a high degree in the process of selection. No one can be made to believe that the hand of man was formed with reference to playing the piano. It is adapted to grasping and to delicate touch; and, since these faculties are of great use in the struggle for existence, there was nothing in the way of making a finer fashioning of the hand already present in animals, agreeable with that process. In this way it has become finely fingered, delicate, and flexible as we know it, and as we find it even in the lowest savages. We can do with this hand a great many things that were not contemplated—if we may be permitted the expression—in its structure; among others, play the piano, that instrument having been invented; and a wild African, if we drill him to it from childhood, can, under the conditions of modern piano technics, learn it as well as a civilized child. The same is the case, I believe, to a considerable degree, in the artistic musical sense. That is, in a certain sense, a hand with which we play on the soul, but a hand that was not originally designed for that purpose—that is, did not originate out of the necessity of our discovering music, but out of entirely different necessities. This assertion is in need of a fuller demonstration. Our musical faculties consist of two parts: one, the organs of hearing proper—the outer, middle, and inner ear, which translate the different tones into nerve-movements; and the second, of the brain part, which converts these nerve-movements, when they have passed through the auditory nerve, into tone-perceptions, and the auditory center of the brain.

The first part of this duality—the organ of hearing proper—is not, so far as we know, much more highly developed in man than in many animals; and is not in other ways so constructed that we can conclude that it contains any different capacity from that of those animals for hearing music. The higher animals can also enjoy music, as my house-cat shows, when she comes at the play-

* From an article in the Deutsche Rundschau.

ing of the piano to sit by the player, and sometimes jumps into her lap or on the key-board of the instrument. I know of a dog, too, in a family in Berlin, which comes in in like manner when there is music, often from distant rooms, opening the door with his paw. I knew of another dog, usually thoroughly domestic, which occasionally played the vagabond for love of music. Whenever the semi-annual mass was celebrated in the city he could not be kept at the house. As soon as the so-called *Bergknappen*, which were accustomed to play at this time in the streets, appeared, he would run away and follow them from morning till evening.

Evidently neither cats nor dogs, nor other animals that listen to human music, were constituted for the appreciation of it, for it is not of the slightest use to them in the struggle for existence. Moreover, they and their organs of hearing were much older than man and his music. Their power of appreciating music is therefore an uncontemplated side-faculty of a hearing apparatus which has become on other grounds what we find it to be. So it is, I believe, with man. He has not acquired his musical hearing as such, but has received a highly developed organ of hearing by a process of selection, because it was necessary to him in the selective process; and this organ of hearing happens also to be adapted to listening to music.

It can not be said that this has been produced in man by natural breeding, or that it may not have been formed previous to the human period. We know nothing of our direct predecessors; and, even if their remains should be found, the bony parts of the organs of hearing in their skulls would furnish no clew to the microscopic particulars of the soft parts with which they were covered during life. It is, however, most probable that the precursors of man had nearly the same organs that he has now; for the living caricatures of men, the apes, have them in nearly the same perfection. We have a right to assume this, although we have not such detailed examinations of these organs as Hasse and Retzius have given us of similar organs in other mammals. We can not determine whether the compass of the scale audible to apes is quite as large as that of men; but we are authorized to presume that it is about the same. The power of perceiving the intervals between musical tones depends on a complicated apparatus in the coil of the ear. This apparatus, called, after its discoverer, the organ of Corti, includes thousands of nervous hair-cells, each of which is excitable only by a single tone of definite pitch. The delicacy of one's auditory apparatus—the correctness of Helmholtz's interpretation of the significance of these organs being presupposed—depends on the number of these hair-cells. According to the exact measurements and enumerations of Retzius, there are 15,500 of them in the ear of man, 12,500 in that of

the cat, and 7,800 in that of the rabbit. Hence man has a more perfect hearing than those animals, although we are not able yet to determine whether his superiority consists in finer delicacy or greater compass; possibly in both. There are also differences, but probably not of great extent, in the number of auditory cells between men; and we can explain by these differences why some persons can hear more sharply, or lower tones or higher tones, than others. I myself have a passably fine musical ear, but I can not hear the high tones in which certain species of grasshoppers make music, though hundreds of them may be "fiddling" at the same time, and although other persons recognize them without difficulty.

The question now arises how, if only useful qualities become established, this property of perceiving musical tones, possessed by rabbits and cats in substantially nearly the same degree with man, originated. It must be a matter of indifference to these animals, which do not make music, whether they have a musical sense or not, and the development of their hearing apparatus must have gone on with reference to other needs of theirs. What were those needs? In what respect is it useful to animals to have the power of perceiving so great a number of distinct tones as are provided for in their hearing apparatus? The question has never been discussed, and I confess that the answer is not easy, if a full and detailed explanation is sought. But in a general sense the reason seems easily comprehensible. Wild animals need a very fine ear—beasts of prey, like cats, in order that they may hear and distinguish all the tones that are emitted by their game. A considerable scale is at once in demand for this; one, for example, which shall enable the wild cat to distinguish the cooing of the dove, the call of the cuckoo through all its tones, and those of the thrush, finch, linnet, pheasant, and the other birds and little animals of the wood and field. The wild animal must also be able to distinguish the sounds of his enemies—whether it be the intended victim having to escape his pursuer, or the beast of prey avoiding a rival; to the list of which, already large, has been added man, who appeared after animals' organs of hearing were fully developed. For this purpose the hearing of these animals should be capable of perceiving low tones and high tones, and the complete series of tones between. A feeling of wonder comes over us when we see how highly developed the hearing of animals is, and we can hardly comprehend it except we consider to what an extent their existence in the wild condition depends upon an extreme delicacy of the organ. There must be no uncertainty in their minds as to the kind of source whence any sound comes. A mistake may be a matter of life and death to them. The food of a beast of prey is precarious, and he can not afford to let any

opportunity of supplying himself pass. It is not for nothing that the fox watches night and day intent to take notice of the lightest movement in the air; or that the hare is a proverbially timid beast, for the existence of his species depends upon his being on the alert. We can thus understand to a certain extent why the rabbit has 7,800 auditory cells in his organ; a number that represents a wonderfully delicate refinement in his hearing, even if we do not suppose each of these 7,800 cells to correspond with a different tone, as, if we regard each cross-shaped group of four cells as representing a single tone, this would give an exceedingly large number—about two thousand—of tone-perceptions. We may realize how delicate must be the hearing that appreciates even a thousand tones when we recollect that our concert-piano scales give only eighty-seven tones. Even if we take a scale of greater compass, as of a hundred tones at intervals of a semitone, our rabbit will have capacity to distinguish nineteen intertones in each half-tone interval. We, ourselves, if we exercise our full power of hearing, could distinguish some thirty intertones between the tones A and B♭ of our scale—a few more than the difference in the number of vibrations corresponding with those notes (A=440, B♭=467·5).

To make this highly developed organization of the ear of real benefit to the animal, the parts of the brain corresponding with the auditory nerves must be constituted with like delicacy. So also must those parts which serve for the remembrance of sensations. For, without memory and the power to profit by the lessons of experience, those powers would be of little use to the animal.

It is only in a few instances that we can ascertain with any degree of sufficiency how far an animal is capable of really comprehending our music. The capacity often appears to be considerable; for it is well known that cavalry-horses frequently learn to recognize the signals given by the trumpeters as well as their riders do, and to make the motions answering to them before they are directed to do so. We have, furthermore, in many birds, which are far below the mammals we have named in mental capacity, good evidence that our music can be heard and comprehended by beings whose hearing apparatus has not been adapted to those ends. I refer especially to birds which have no or only very simple songs of their own, and are yet able to imitate both the more varied songs of other birds and human melodies. This is conspicuously the case with some of the parrots, which can learn to repeat short melodies well and distinctly. They also possess the proper organs for hearing music, although they do not themselves make it. Thus our proposition seems well founded that, as man possessed musical hearing organs before he made music, those

organs did not reach their present high development through practice in music.

Among the objections that may be brought up against this theory, the most real is that founded on the existence of persons without musical sense; who can hear ordinary sounds and intonations as well as musically gifted persons, but who can not define musical intervals, can not take up a melody and repeat it, and can not analyze harmonies. If their organs of hearing are as well developed as those of musicians, that would seem to be evidence that the musical sense is something else than ordinary hearing, and supplementary to it. But it has not been demonstrated that the hearing of unmusical persons is as well developed as that of musicians, and I regard it as highly improbable. Although we have no accurate data on the subject, the facts we have do not sustain the proposition. The idea of unmusicality is a relative one. Mozart had so wonderful a recollection of tone-pitches that he could detect a difference of a quarter of a tone between a violin he was playing and one which he had played on two days before. Other men, whom we regard as men of high musical talent, have only the weakest, or no memory at all, for absolute tone-pitches. They can not tell whether a piece is played in A, C, or F, but are satisfied if the tone-intervals within the piece are properly represented. Defects of this kind are corollaries of want of practice, and result to a large extent from the considerable part which the piano fills in musical teaching. The sense of players on the violin —an instrument on which minute intervals of tone can be produced—is much clearer and more delicate than that of players on the piano. The various degrees of defect in musical sense seem to me to depend on a more or less imperfect structure of the organs of hearing. Defects and aberrations appear in all parts of the body, and must be particularly apt to overtake an organ which, like the ear of man, is now no longer of the importance for maintaining the species which it must have been several thousand years ago when man was still in a state of nature. Or there may be defects in the brain-centers that receive the nervous impressions, or in the connections between the brain and nerves. Light is cast upon these instances through the accounts of cases of aphasia and musical impotency, in which, through injury to a small spot in the brain, the faculty of appreciating or producing music is partly or wholly removed, usually in connection with disorders of speech. Besides the older observations of Kussmaul, Kast, Knoblauch, and Oppenheim have made interesting contributions on this difficult and complicated subject.

Have we a right to suppose that the musical gifts of the primitive man were the same as we have to-day? Can we imagine that men were born in the earliest ages who might have furnished a

Haydn, Mozart, or Beethoven, or have acquired even the average musical skill of our day? I do not believe it; for something else is needed for the comprehension of our present higher music than the musical apparatus of our ear and brain-center, and more than the musical instruction that can be given in one person's lifetime —a refined, impressionable, cultivated soul.

The auditory center of the brain often spoken of is not simply theoretical, but is defined with fair certainty. If, in a dog or an ape, a particular spot in the temporal fold of the cerebrum is destroyed on both sides, the animal will be made deaf, although his ear-organs have not been disturbed. The animal's general health is not impaired; it continues to live, but it ceases to hear. Noises passing through its hearing apparatus still excite nervous vibrations, and these are still transmitted to the brain; but the organ is lacking there which should convert them into tone-perceptions and bring them to consciousness. The animal is "soul-deaf." If, again, we were able to remove all the other parts of the cerebellum and leave the hearing centers untouched, the mechanical process of the production of tone impressions would still go on, but the animal or the man would hear nothing, because there would be nothing left in his brain to make him conscious of the tone-impressions. With the rest of the cerebellum was taken away the intellect, with all its side-faculties of feeling, fancy, self-consciousness, etc. The "soul" is wanting, and without it the finest musical notes, brought to place in the hearing center, make no impression.

I have brought forward this hypothetical case to show that the way in which music is comprehended depends not only on the auditory centers, but as much on that which lies behind them, which takes up the tone-images formed by them and gives them reality—the "soul." If there is no "soul," as in the supposed case, then the tone-images are not perceived; if a highly developed, tuneful, and thoughtful human soul is present, then the confluent and contrasted voices of a polyphone music are perceived as a charming musical structure, a rich art-picture, the single parts of which stand in perceptible connection; going out from one another, running back into one another, the individual tone-pictures shape themselves by ever new variations into ever new and interesting combinations. But if there is only the relatively lowly organized brain of an animal, a parrot, for instance, then the spiritual power of the complicated tone-picture will not prevail, and only a possibly pleasant confusion of sounds is perceived. The parrot will never be able to follow the course of a piece of music, because he lacks the necessary degree of intelligence, but will only be able to repeat snatches of it, with no comprehension of the connection of the parts. Hence we conclude that affections

of the same organs of hearing and of the auditory centers appertaining to them must produce different effects on the "soul" according to its degree of development. The "soul" is in a manner played upon by the musical movements of the auditory centers as if it was an instrument; the more complete the instrument, the greater the effect. Hence the comprehension of our music by the highest animals—the dog, the cat, and the horse—is exceedingly imperfect, because of their limited mental development. Music strikes them as pleasant or unpleasant, or attracts them, independently of what we call the character of the piece. The same differences, except in a lesser degree, must prevail in the different stages of development of the human soul. If the primitive man did not have a mind equal to ours; if man's intellect and all that depends upon it has been growing sharper and more profound during the thousands of years of his struggle for existence, his faculty for comprehending music must also have been enlarged in the course of time. For this reason we can not suppose that any Beethovens were concealed among primitive men, or are running around among contemporary Australians or negroes. For that is needed, not only a strongly cultivated musical sense, but also a rich, great, deeply emotional soul such as accompanies an intellect schooled according to the sum of its experiences. I will go further, and say that I do not believe that a child of one of these primitive men, if he were given to us to-day, could be trained to the same degree of musical appreciation as our children are capable of. The native higher mental faculties would be wanting in him. While savages are lower in mental development than civilized man, and while we recognize that man's receptivity for music has grown with his mental development, we must doubt if any increase in the power of the human mind has taken place in historical times. The civilized natives of antiquity appear to have already reached a very high degree of mental capacity; and their lawgivers, poets, philosophers, architects, and sculptors have had no successors superior to them. We have a right to suppose also that the ancients had the same musical sense and talent for music as we; and that, if their music was inferior, it was not for lack in that direction, but for the want of the products of the continued exercise of the musical talent—of invention and discovery—acquired and transmitted from generation to generation, and added to, by the aid of which we have reached our high degree of cultivation. Although man's physical power may not increase, we have a right to expect an almost unlimited advance of mankind in mental cultivation, by each generation building upon the stage which its predecessor had reached, and thus continuing perpetually to go higher.

HUMAN HEREDITY.

By JAMES H. STOLLER,
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IN common speech we use the term heredity as signifying simply that principle by which the qualities of parents are transmitted to their children. We give the term a meaning broad enough to cover facts which come within our ordinary notice. We see that the features of children—the shape of the brow and nose, the color of the hair and eyes—bear a resemblance to those of the parents; as they grow older we notice not only physical but also psychical resemblances—the temperament, tastes, and aptitudes are more or less like those of the parents. We find an explanation of these likenesses in the principle of heredity; and, as no evidence of any deeper operation of such a principle comes within our ordinary observation, we limit it to these particulars. It is true that occasionally we are reminded that the principle may extend to a second generation; we see the traits of the grandparent reappearing in the child, this being most noticeably true in respect to certain bodily disorders, as scrofulous diseases and certain forms of insanity. But we seldom think that the principle of heredity operates through more than the two or three generations of our immediate ancestors, or that any other qualities than those which are specifically peculiar to us—that mark our individuality of body or mind—come to us by it.

A little reflection, however, must convince us that this principle works more deeply. Those qualities that distinguish us as members of a nationality—whence come they? As Americans we pride ourselves that there is something distinctive about us, that places us in a different category from Englishmen and Frenchmen. Whence come these national characteristics? They were possessed by our fathers and our grandfathers, and the immediate inference, therefore, is that they come to us by inheritance. Of course, we have to consider that the fathers who were the founders of the nation did not inherit the American characteristics, since we must regard them as the original possessors of them. The fact seems to be that national characteristics originate in external causes, but once established they are perpetuated by inheritance. It may be urged, of course, that external causes operate upon succeeding generations as well as the antecedent one, as evidenced in our nationality by its rapid absorption of foreign stock. No doubt the direct influence of our institutions is a constant force in the development of the national characteristics, and goes a great way toward Americanizing citizens of foreign birth even in a single generation. But to native-born Ameri-

cans this influence simply adds itself to that of inheritance, and does not diminish its strength or importance. Taking a general view of the question, the case becomes very obvious. It will scarcely be disputed that national characteristics manifest themselves definitely, not only in the temperament, ideas, etc., of the people, but also in their bodily features. We speak of the English type of facial features, the German type, etc., and every one appreciates that these terms express real distinctions. Moreover, we know that these types have existed a long time, slightly variable, no doubt, but never losing the main lines. It is scarcely necessary to say that this continuance of type rests on heredity. The case is precisely the same as that of the continuance of the family likeness, only the family is larger and the features less distinctive, though, in the long run, they are more faithfully conserved.

Lying deeper than those characteristics that mark us as members of a nationality are others that mark us as members of one of the great races of the human family. The term race has different significations according to its use, whether referring to distinctions chiefly of an anatomical character (though connoting others), as the Caucasian, Mongolian, etc., races, or to distinctions based more directly on differences of lineage, as the Celtic, Teutonic, etc., races. For the purpose in hand we use it in the former sense, dividing mankind into the usual five races, Caucasian, negro, Indian, etc. Now, it is obvious that our race characteristics come to us in the same way as our national and family characteristics: we get our white skin and orthognathous skulls by inheritance just as truly as our more specific bodily features, only these qualities come to us from ancestors more remote. We need not concern ourselves here how they obtained them, nor whether they were acquired suddenly in a single generation or gradually through many generations. The point to be insisted upon is that, race characteristics once established, they are transmitted by inheritance through all succeeding generations. Of course, the principle applies not only to merely anatomical features, but to mental traits as well. The peculiarities of mental constitution that make the Caucasian the most progressive race are handed down by inheritance just as truly as the color of the skin and the shape of the skull.

Still deeper than the race characteristics—more fundamental than they—are those that mark us as members of the human family itself. Our convoluted brains, our power of verbal speech, certain of our intellectual and our moral faculties, these are the qualities that belong to us in common with all men, and that distinguish us from the highest animals. Whence came these qualities? It can only be answered that they came from the

fathers of the race, having been transmitted by the law of heredity through the successive generations to us. It matters not whether the race originated in a single pair or had a multiplex origin, nor are we here concerned how our progenitors came to possess these qualities at all; the fact at hand is that, once having lived, they transmitted to their descendants down to us their distinctive human qualities.

The facts to which our attention has now been given are summarized as follows:

All the qualities of our human nature come to us by inheritance.

Those qualities which are strictly individual—the "skin-deep" qualities—come to us from our immediate ancestors, our parents and grandparents.

Those qualities which are less specific, which we have in common with others who live under the same laws and institutions, and generally under similar physical conditions, come to us from ancestors more remote, though quite within historic time.

Those qualities which are still more general, which we have in common with others of the same general physical features, came from ancestors much more remote, whose records are lost in prehistoric time.

Those qualities which are broadly anthropological, which we possess in common with all members of the human family, came to us from the original progenitors of the race.

We have thus far considered only the strictly human qualities of our nature. We have now to consider whether the operation of the law of heredity extends also to the animal qualities. Let us first notice those which man possesses in common with the highest animals. They are, a vertebral column, giving form and flexibility to the body; two pairs of limbs for prehension and locomotion, mammary glands supplying food for the young; a four-chambered heart and double blood-circulation; and, finally, a well-developed nervous system, with sense-organs, placing the animal in conscious relation with the external world. Does the principle of heredity by which, as we have seen, all our anthropological qualities have come to us, give us also these zoölogical qualities? The point here to be enforced is, that if the answer to this question is not in the affirmative, then there is a break in that law, the operation of which we have seen to extend from the most specific to the most general anthropological qualities. In considering whether there is such a break, the special point of inquiry is whether the two classes of qualities, the anthropological and the zoölogical, are different from each other in kind. For, if they be the same in kind, the presumption is that the law operates in respect to both; in other words, that there is no break. The an-

thropological qualities are, as we have seen, partly physical—the shape of the skull, the structure of the brain, the color of the skin—and partly psychical, the intellectual and moral faculties. The zoölogical qualities are also partly physical and partly psychical; of the former class, the general structure of the body and the particular structure of organs, as the heart, lungs, glands, etc.; of the latter class, the faculties of intelligence. It appears, therefore, that the zoölogical qualities are the same in kind with the anthropological, and the inference, therefore, is that the law of heredity extends also to them. That is to say, as we proceed, step by step, from the most specific to the most general qualities peculiar to man, and then by the next step pass to those qualities which we possess in common with the highest animals, we find that the last term of the series is the same in kind with the others, and all the reasons that lead us to conclude that the law of heredity extends successively through the first terms of the series lead us to conclude that it extends also to the last.

The fact that not all the anthropological qualities have their zoölogical prototypes does not at all affect the force of the inference. We may allow, for example, that the moral faculties are strictly anthropological; but this does not detract from the evidence that the intellectual faculties came from the zoölogical prototypes, any more than the fact that the Italian people have dark complexions detracts from the evidence that they descended from Caucasian progenitors. In other words, the possession of specific qualities by a class—qualities not received by inheritance—affects in no way the evidence that the general qualities of the class were received by inheritance. We have recognized this principle at each step in the present discussion. For example, we saw that the national characteristics of a people arise from other causes than inheritance, but this did not lead us to conclude that the race characteristics of the same people were not inherited. In fact, every person affords in his own facial features an illustration of this principle. The expression of our countenances, whether intelligent or dull, cheerful or grave, etc., has been determined by the circumstances of our lives—education, etc.; but the anatomical features—color of eyes, shape of nose, etc.—are inherited from our parents.

Our conclusion, therefore, is that the evidences that man has inherited his anthropological qualities apply equally as well to his having inherited his zoölogical qualities.

Below those qualities which man has in common with the higher animals are others which he possesses in common with the lower animals also. These are chiefly anatomical and physiological in character, such as the possession of bodies whose structural units consist of cells, organs which perform the functions of ali-

mentation, reproduction, etc. The reasoning already employed leads us to conclude that these lower animals were the ancestors of the higher, and transmitted to them the qualities which the two classes possess in common. For example, both the higher and lower animals possess an alimentary canal — a tube running through the body for the reception and digestion of food. We conclude that this alimentary canal was not obtained by the higher animals through external causes, but by inheritance from the lower animals.

We have, finally, to consider those qualities which man, and both the higher and lower grades of animals, possess in common with the very lowest animals. These lowest animals, consisting in respect to their physical characters simply of minute jelly-particles, destitute of organization, agree with the higher animals only in their physiological properties. These are essentially only two, nutrition and reproduction. These, indeed, are the two absolutely fundamental and essential properties of any living organism. Without the one, the life of the individual ceases; without the other, the life of the species. From the biological point of view, the carrying out of these two functions of nutrition and reproduction is the sole end of existence of any living being. Animals differ from one another—they occupy a lower or higher place in the scale of life—according to the advantages of organization enabling them to carry out these functions. The special powers possessed by animals which at first sight seemed to be ends in themselves, are seen by a moment's reflection to be only subservient to these two great ends. In birds, for example, both those powers depending upon structural perfection, as flight, vision, song, and plumage, and those depending upon a highly developed nervous system, as the instincts of migration and nest-building, serve, in the end, wholly to better enable the animals to maintain their own life and that of their species—to carry out the functions of nutrition and reproduction. Thus, rapid flight and keen vision enable them to procure food; melodious notes and brilliant plumage are sexual attractions; while migration and nest-building are directly connected with nutrition and reproduction respectively. From these considerations it is seen that, to the biologist, the simplest animals—the animate jelly-particles—are beings of far higher rank than their physical simplicity would indicate, since they carry on the same life-processes that other animals do, only lacking parts and organs subserving the operation of these processes. It is, therefore, only to assume that like proceeds from like to suppose that from these simplest animals the higher forms received by the law of heredity the two powers of their being which all possess in common—nutrition and reproduction. The differences subsisting between these lowest animals and the higher

are not differences relating to the life-function, but merely to the physical forms in which life manifests itself.

As we know of no simpler organisms than these, and can not conceive that life could manifest itself in any simpler forms, we must regard them as the primordial animals—the progenitors of the animal kingdom.

The conclusion which we reach, then, is that not only all man's distinctively human qualities came to him by inheritance, but also all his purely animal qualities. The former came from human ancestors, the latter from animal ancestors. And as with the former, so with the latter; the more specific came from ancestors less remote, the more general from ancestors more remote. The most general, the absolutely fundamental and essential, came from the primordial living beings.

The animals of the first life-period were succeeded by others which, as we have seen, possessed not only the physiological characters of the primordial organisms, but also certain anatomical characters not received by inheritance, enabling them to carry out the physiological processes more perfectly. If for the sake of simplicity we consider the animals of the first and second life-periods to be those which we have already designated as the lowest and the lower animals respectively, then the latter received by inheritance from the former their functions of nutrition and reproduction, and acquired the special organs of alimentation and reproduction by which these functions were the better carried on. The question whence these new characters came need form no part of our present inquiry. For our purpose it will be sufficient to say that they resulted from external causes, it being understood that it is not intended to preclude the idea of the agencies in question being natural causes. The fact here to be set forth is that these animals of the second life-period transmitted, by the law of heredity, these characters that first appeared in them, along with those which they had received by inheritance, to their descendants. It is not to be supposed, of course, that the characters were preserved unmodified as to details, but only that their general nature, both as to structure and use, were retained. The animals of the third life-period—which we may consider those we have called the higher animals—therefore possessed at the outset all the characters of the first, together with those that were peculiar to the second. They, in their turn, under the influence of external causes, came to possess new characters—a vertebral column, four-chambered heart, etc.—while those which they had received by inheritance from their forerunners of the second period attained in them a higher development; in their turn, too, they transmitted their advanced organization to the succeeding order of beings—that is, to the human race. This

same process continued through the successive generations of the human family. The distinctively human qualities acquired at the outset, together with the accumulation of inherited animal qualities, were handed down to the races that succeeded. They, in turn, bestowed all that had been bequeathed to them, together with their newly acquired race characteristics, to their descendants. Finally, the national characteristics, which in our time we may suppose to include all the traits that characterize civilized man, were differentiated.

Civilized man, therefore, inherits the accumulation of benefits that have come from the operation of the law of heredity through the long ages since life began upon the earth. In a deeper sense than we commonly think, we are the heirs of all the ages.

Man does not come into his full inheritance at the beginning of his existence. It is a fact of exceeding significance that, at the beginning of embryonic life, our bodies consist of nothing more than a single cell, precisely similar to the minute organisms with which life began upon the earth. It is as if man acknowledged the debt which he owes to these primordial living beings. But it is not only to the primal form of life that he makes this confession of affinity; for, as is well known, the successive stages of embryonic development represent the succession of type forms of animal life as they appeared upon the earth. Thus, man comes into his inheritance by degrees. At the beginning of his existence he possesses the characters of the primal forms of life; a little later, those of the second life-period—such as belong to the lower animals; still later, those of the third life-period—such as belong to the higher grade of animals. At a considerable time before birth he has already come into possession of all the animal qualities, and at birth the human physical characters are present. Then follows a more perfect development of the physical characters, and at the same time the acquirement of the higher human characteristics—the power of speech and the mental and moral faculties. Thus, in the unfolding embryo and in the growing child we have recorded in dim but unmistakable characters the history of the life of the earth.

A suggestion, looking to the future, here presents itself. The same agencies out of which has come the progress of the past are in operation now. It is, therefore, only in the course of nature that there should be a further progress. And as respects man, according to a law that has governed in the past, namely, that the most recently acquired characters of a type are most subject to progressive change, we may expect that advancement will be chiefly in respect to his higher powers—his intellectual, moral, and spiritual nature.

A TALK ABOUT METEORITES.

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METEORITES are particularly interesting because they comprise the only material coming to us from outer space. In consequence of the striking phenomena resulting from their rapid passage through our atmosphere, making them appear like balls of fire visible at great distances, sometimes exploding with such violence as to be taken for earthquakes, their falls have been noticed and recorded since the earliest times. The accounts, however, were so imbued with superstitions, and so distorted by the terrified emotions of the narrators, that in most cases the witnesses of the event were laughed at for their supposed delusions, and it was not till the beginning of the present century that men of science and people in general began to give credit to such reports.

The earliest authentic records of stones falling from the sky are to be found in the Chinese annals, which go back to 644 B. C., and between that time and 333 A. D. Biot has traced sixteen distinct occurrences. In Europe, a meteorite is said to have fallen in Crete as far back as 1478 B. C., but Greek history can not be depended upon for events earlier than 700 B. C. A more probable fall, in 705 B. C., is mentioned by Plutarch; while Livy, in his History of Rome, gives an account of a shower of stones which fell on the Alban Mount about 652 B. C., and which so impressed the senate that they decreed a nine days' solemn festival. Again, in 456 B. C., a stone fell at Ægospotamos, in Thrace, which is mentioned in the Parian Marbles, and also by Plutarch and Pliny, which is said to have been of the size of two millstones, and equal in weight to a full wagon-load. Still more famous was the meteorite which fell 204 B. C. in Phrygia, described as conical in shape, of a deep-brown color, and looking like a piece of lava, and so pointed at the top that it was called the "needle" of Cybele. This stone was believed to have fallen from heaven, and was worshiped at Pessinus by the Phrygians and Phœnicians as the Great Mother of the Gods. At the time of the second Punic war, upon the announcement by an oracle that its possession would secure continued prosperity to the state, it was demanded from King Attalus and taken with great ceremony to Rome, where it was mounted on a silver statue of the goddess in place of the head. Signor Lanciani has traced its existence down to 1730. It was then finally lost sight of, but he thinks it may still exist, buried in the ruins of the Palace of the Cæsars. The Diana of the Ephesians, "which fell down from Jupiter," and

the Image of Venus at Cyprus, are now considered to have been similar meteoric masses.

There is a stone whose history goes back at least twelve centuries, built into the northeast corner of the Kaaba at Mecca, held in great reverence by the Moslems, which is supposed to have had a similar origin.

There are also numerous accounts of meteorites having been worshiped in more modern times. One which fell about one hundred and fifty years ago was worshiped for some time in the temple of Ogi in Japan; and a stone which fell in a field near the village of Dooralla, in India, in 1815, was immediately decked with flowers, and the natives would have built a temple over it were it not for a powerful constraint which took it to the British Museum.

Undoubtedly the oldest meteorite still preserved is one now in the Harvard collection, which was found by Prof. Putnam on the altar of Mound No. 4 of the Turner Group (Little Miami Valley, Ohio). It possibly had been an object of worship to the old mound-builders during some prehistoric age, and the worship of such sky-stones is considered by many writers to have been the oldest form of idolatry. It is well known, however, that meteoric iron was used by the mound-builders for coating bronze ornaments with a white metal; and two meteoric fragments, consisting wholly of iron, were found on a neighboring altar. Many such ornaments are to be found in our museums. There is an account in Dio Cassius of an attempt, under the Emperor Severus, to coat bronze coins with silver which was said to have come down from heaven. The same mistake of taking meteoric iron for silver is frequently made in the present day, owing to an unusual whiteness of the iron and its extreme malleability.

The oldest undoubted meteorite seen to fall was, till recently, suspended by a chain from the vault of the parish church of Ensisheim, in Alsace. The following, translated from a document still preserved in the church, gives an account of its fall:

"On the 16th of November, 1492, a singular miracle happened; for, between eleven and twelve in the forenoon, with a loud crash of thunder and a prolonged noise heard afar off, there fell in the town of Ensisheim a stone weighing two hundred pounds. It was seen by a child to strike the ground in a field near the canton called Gisgaud, where it made a hole more than five feet deep. It was taken to the church as being a miraculous object. The noise was heard so distinctly at Lucerne Villing and many other places that in each of them it was thought some houses had fallen. King Maximilian, who was then at Ensisheim, had the stone carried to the castle; after breaking off two pieces, one for the Duke Sigismund of Austria and the other for himself, he forbade fur-

ther damage, and ordered the stone to be suspended in the parish church."

In 1768 a stone was seen to fall at Lucé, in France, and three French Academicians, one of whom was Lavoisier, were appointed to investigate it. As they were convinced beforehand that the stone could not have fallen from the sky, they reported to the Academy that it was an ordinary stone, which had been struck by lightning.

The German philosopher Chladni, in 1794, was the first to bring together the accounts of bodies said to have fallen from the sky, and he felt confident in his conclusion that at least two of these came from outer space. One was the now well-known Pallas meteorite, found by a Cossack, in 1749, on the top of a lofty mountain, and brought by the traveler Pallas from Krasnojarsk, Siberia, in 1772. The mass, consisting largely of iron, weighed fifteen hundred pounds, and was thought by the Tartars to be a holy thing fallen from heaven, because it differed entirely from all the rocks of the country. The second was one found, in 1783, by Indians, projecting a foot above the ground, at Otumpa, province of Tucuman, Argentine Republic. It was thought to be an iron-mine, and Don Michael Rubin de Celis was sent to investigate it. He reported that it was a mass of iron weighing about thirty thousand pounds, and that there was no other iron in the neighborhood, and no stones, and no human habitations.

Chladni argued that these two masses of iron must have been formed through fire, and, as there were no signs of volcanoes in the countries where they were found, and as volcanoes had never been known to eject masses of iron, he concluded that they must have come to our earth from space.

Two months after Chladni had advanced his theory, there fell a shower of stones at Siena, in Tuscany, an account of which was given in a letter received by Sir William Hamilton from the Earl of Bristol, dated Siena, July 12, 1794:

"In the midst of a most violent thunder-storm, about a dozen stones of various weights and dimensions fell at the feet of different persons, men, women, and children. The stones are of a quality not found in any part of the Siennese territory: they fell about eighteen hours after the enormous eruption of Mount Vesuvius, which circumstance leaves a choice of difficulties in the solution of this extraordinary phenomenon. Either these stones have been generated in this igneous mass of clouds which produced such unusual thunder, or, which is equally incredible, they were thrown from Vesuvius at a distance of at least two hundred and fifty miles; judge, then, of its parabola. The philosophers here incline to the first solution. I wish much, sir, to know your sentiments. My first objection was to the fact itself, but of this there are so

many eye-witnesses it seems impossible to withstand their evidence."

As the wind was from the north when the stones fell at Siena, while Vesuvius was to the south, it was suggested that the cloud from which they came had been blown all the way from Vesuvius past Siena and then back again, before it condensed.

The next meteorite seen to fall was in England itself. On December 13, 1795, a stone weighing fifty-six pounds fell at Wold Cottage, in Yorkshire, at about three o'clock in the afternoon, and several persons saw it fall. It fell on a perfectly clear day, and penetrated twelve inches of soil and six inches of chalk rock. In the neighboring villages sounds were heard which were taken for the firing of guns at sea, and in two villages there was such a distinct sound of something whizzing through the air toward the house of a Mr. Topham that several people ran there to see what had happened. When the stone was dug up it was warm and smoked. It was exhibited in London, and handbills were distributed giving an account of its descent. Such advertising, however, did not tend to make people believe in the celestial origin of the stone; and, as there were no volcanoes in England, it was thought that it might have been condensed from a cloud of ashes blown from Mount Hecla in Iceland. We do not, however, have to go back one hundred years to find wild hypotheses as to the probable origin of meteorites. Even now very little is known, and the field for speculation is nearly as unlimited as it was then, though the theories of a few centuries ago are simpler and more amusing than the recent ones. In the chronicles of the Benedictine monks a theory of the origin of meteorites is given briefly thus:

"In the year 921, in the time of Lord John X, pope, in the seventh year of his pontificate, signs were seen; for, near the city of Rome, many stones were seen to fall from the sky—such dreadful and terrible ones in the city of Narnia that people had to believe that they were brought straight from hell. The very biggest of the stones, falling into the river Narnius, can be seen to this day, projecting a cubit above the surface of the water."

A Persian philosopher, Syed Abdulla, in 1814, describing a fall of stones near Bombay, says: "The causes of this may be, that in the course of working (or of changes on) the ground, air being extricated, may have entered into combination, and come near elemental fire, and from this fire have received a portion of heat; that then it may have united with brimstone and terrene salt, as, for instance, saltpeter; when the mixture, from some cause, being ignited, the fire bestows its own property on the mass, and the stones which may have been above it are blown into the air—God knows the truth."

In 1818 Dr. W. G. Reynolds, in offering a theory on meteorites, says: "Dr. Blagden considers electricity as the general cause of these phenomena; Dr. Gregory and others think they depend on highly inflammable matter, as phosphorus, phosphorated hydrogen, etc., being volatilized and congregated in the upper regions of the air. Dr. Halley ascribes them to a fortuitous concourse of atoms, which the earth meets in her annual track through the ecliptic; and Sir John Pringle seems to regard them as bodies of a celestial character, revolving around centers, and intended by the Creator for wise and beneficent purposes, perhaps to our atmosphere, to free it of noxious qualities, or supply such as are salutary." Dr. Reynolds then goes on to elaborate a most complicated theory in which solid substances on the earth are changed to vapor by the sun's heat; these, rising as gases, finally give up their heat by an explosion, and the particles, having no heat to keep them apart, rush together and come down as solids.

"While the minds of the scientific men of France were in this unsettled condition, there came a report that still another shower of stones had fallen, this time in their own country, and within easy reach of Paris. To settle the matter finally, if possible, the physicist Biot, member of the French Academy, was directed by the Minister of the Interior to inquire into the event upon the spot. After a careful examination of the stones and a comparison of the statements of the villagers, Biot was convinced that—

"1. On Tuesday, April 26, 1803, about 1 P. M., there was a violent *explosion* in the neighborhood of L'Aigle, in the department of Orne, lasting for five or six minutes; this was heard for a distance of seventy-five miles round.

"2. Some moments before the explosion at L'Aigle, a *fire-ball* in quick motion was seen from several of the adjoining towns, though not from L'Aigle itself.

"3. There was absolutely no doubt that on the same day many stones fell in the neighborhood of L'Aigle.

"Biot estimated the number of the stones at two or three thousand; they fell within an ellipse of which the larger axis was 6·2 miles, and the smaller 2·5 miles; and this inequality would indicate not a single explosion but a series of them. With the exception of a few little clouds of ordinary character, the sky was quite clear.

"The exhaustive report of Biot, and the conclusive nature of his proofs, compelled the whole of the scientific world to recognize the fall of stones on the earth from outer space as an undoubted fact."*

The main difficulty in forming theories at the present time is

* British Museum Catalogue of Meteorites.

due to the fact that there are two distinct classes of meteorites, irons and stones, the characteristics of which make it difficult to assign a like origin to both. It is probable, however, that they all belong to our solar system; that they are revolving round the sun in some different plane from the ecliptic, and that the earth is constantly meeting them in its yearly journey. When they come into contact with our atmosphere, although they are moving with planetary velocity—sometimes at the rate of forty-five miles a second, more than twice as fast as the earth moves in its orbit—their motion is rapidly reduced, owing to the resistance of the air, so that in most cases they come to the ground like a spent cannon-ball. Their passage through the air is only of a few seconds' duration, yet the rapid reduction of velocity determines a great heating effect, so that the meteorite, a moment before intensely cold, is immediately fused on the surface, forming a coating varying from a fiftieth to a hundredth of an inch in thickness, and this crust is one of the first characteristics by which a meteorite is recognized. Moreover, the material burns away unevenly, forming pittings or thumb-marks, resembling the marks left by the fingers on a mass of putty—a character also observed on large grains of partially burned powder picked up after the discharge of large guns. The meteorite from Cynthiana, Ky., in the Harvard collection, shows similar marks though more in furrows, made by a flow of the melted surface from the front to the back of the mass during its passage.

The unequal heating of meteorites by the atmosphere causes pieces to crack off, and sometimes the whole mass explodes. In addition, the air rushing in to fill the space behind the rapidly moving body, causes a sound variously compared to claps of thunder, firing of musketry, the tearing of calico, and the like—a noise frequently heard after the passage of the meteorite, owing to the circumstance that the sound travels so much more slowly than the mass itself. Furthermore, the high temperature of the surface causes the mass to glow with a brilliant light, making it appear like a ball of fire, and visible at distances depending on its height above the horizon, sometimes over an area of one thousand miles. Thus a meteorite was seen in 1876 to pass over the States of Kansas, Nebraska, Iowa, Missouri, Wisconsin, Illinois, Michigan, Kentucky, Indiana, Ohio, West Virginia, and Pennsylvania; and explosions were heard like cannonading even to the distance of one hundred and fifty miles from its course. Over Illinois it was seen to break in pieces like a rocket, and over Indiana and Ohio the pieces were computed to cover an area forty miles long and five miles broad. At Rochester, Fulton County, Indiana, during the meteorite's passage, a farmer heard the thud of something striking the ground near his house, and in the morning found a

fragment of rock on top of the snow, which is supposed to be part of the meteorite.

All meteorites appear to be fragments broken off from larger bodies. Sometimes numerous fragments reach the earth, and at other times only single masses. Thus, in the fall at L'Aigle, already mentioned, about three thousand pieces were picked up, scattered over an ellipse more than six miles long. An equally large number fell at Knyahinya, June 9, 1866. Still more at Pultusk in 1868. Several thousand were also picked up after a fall at Estherville, Emmett County, Iowa, May 10, 1879. In such a rain of meteorites the fragments vary greatly in size, some weighing less than a grain, while the largest may weigh a hundred pounds or more. In most cases the peculiar characters or composition of the various specimens make it easy to recognize them as fragments of the same mass. In the case of the Estherville meteorite most of the pieces were coated with a fused crust, owing to the explosion having taken place before they had lost their great velocity.

In the case of a stone which fell at Butsura in 1861, fragments found three or four miles apart could be fitted together, and some of the pieces, though fitting perfectly, had been coated on the faces of juncture with a thin crust, showing that they had been blown apart when the meteorite was still very high in the air.

Meteorites, when not seen to fall, are easily recognized, not only by the characteristic fused crust and pittings already referred to, but by certain very marked peculiarities of structure. There are three large groups: those consisting of metallic iron; those consisting of earthy minerals containing only grains of metallic iron; and those like the Pallas, made up of a continuous network of iron inclosing stony matter. The stony meteorites are usually made up of little rounded grains imbedded in a ground-mass of fragments of the same material, a type of structure called chondritic, which in its details is so characteristic that pieces of the same mass can usually be easily identified, even though found at places or times remote from each other. The iron meteorites are still more easily recognized, although only about nine at most have been seen to fall; for, since iron has not been found in masses of any size in terrestrial rocks, unless in Greenland, these large meteoric fragments are at once noticed wherever found. Stony ones, on the contrary, are not only apt to be overlooked, but the falls of past ages must have been altered and broken up by weathering. Meteoric iron can be easily identified, because it is usually extremely malleable, but at the same time very tough, owing to its being made up of a network of crystalline plates, the plates consisting of pure iron, bounded by layers of an iron-nickel alloy and other impurities, which have separated

out during a slow process of crystallization, evidently from a melted condition. This structure is best seen on a polished surface which has been subject to tempering, or else etched with acid. The acid, acting most readily upon the purest parts of the iron, develops certain figures called Widmanstättian figures if the plates are broad and well marked, and called Neumann lines where they are reduced to fine markings. Till recently, these two varieties of etched figures were supposed to indicate a difference of crystalline structure; but, by a study of the Harvard collection (American Journal of Science, third series, vol. xxxii, p. 284), it has been shown to depend on the time of crystallization —that is to say, on merely the size of the crystals, and not a difference of form. In some cases these etched figures serve conclusively to distinguish irons of different falls, but frequently they vary on the same specimen, or depend on the direction in which the surface is cut; but there are large groups of irons closely resembling each other in their etched characters. The distinction of such irons has become of great importance, since the enormous prices paid for meteorites offers a strong inducement to multiply supposed falls. Iron meteorites are often cut up and distributed by the finders before they have been fully identified, and the confusion is further increased by the natural distribution due to the explosions in the upper atmosphere. Thus a meteorite which fell in Cocke County, Tennessee, some time previous to 1840, has been turning up at various places ever since, and the numerous fragments have been described from time to time under various names as different falls.

In an attempt to prove that an iron which was found in Maverick County, Kentucky, was identical with two Mexican ones, in the Harvard collection (Proceedings of the American Academy of Arts and Sciences, vol. xxiv, p. 30), the writer found that on breaking slabs of the respective irons the two Mexican specimens, which had been generally accepted as identical, showed a marked difference of structure. One of them, known as the Butcher iron, when broken in various directions by blows of a hammer, always exhibited most brilliant and complex crystal faces, some of them half an inch in diameter, certain of the faces being most beautifully marked by a system of fine parallel lines arranged at certain fixed angles. The second iron, on the other hand, from Santa Rosa, would only break in two definite directions, exhibiting a single face with little flaky surfaces, but none of the fine lines. This last iron, if sawed to a thin edge, and then forced to break in a different direction from the two just mentioned, showed only a series of little cube faces, very different from the Butcher iron.

On a similar examination of other irons resembling the two Mexican ones in the figures brought out by etching, irons from

Allen and Maverick Counties, Kentucky, and Chattooga County, Georgia, appeared to be identical with the one from Santa Rosa, though found at places so distant from each other and described as independent falls, while none showed the striking fracture of the Butcher specimens.

As the irons examined were among the most compact and malleable of any in our collections, the result suggests a new way of identifying fragments of the same original mass, where external features are not sufficiently decisive, and, moreover, shows the care that must be taken in determining supposed new falls.

OBSERVATIONS UPON DOUBLING OF FLOWERS.

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FUNCTIONALLY a flower is for the production of offspring, and in structure it may be considered as a transformed stem with its metamorphosed leaves. In a typical flower—that is, one having all the parts present and in an easily recognized form—there are four sets of organs. The calyx forms the outer whorl of leafy organs, and next within is the corolla, usually bright-colored and showy. Inside of these two cycles of floral envelopes are the essential organs: first the stamens, which bear the male element as pollen-grains; and the pistil or pistils, occupying the center of the flower, the lower portion of which bears the seeds. In the production of seed we find the aim and end of all floral structures. The pistil remains after the flowering period is past and becomes the fruit, which may or may not be accompanied by other portions of the flower. The stamens serve their purpose as they shed their pollen, and usually quickly wither away, and the latter is generally true of the petals.

As above stated, all the several parts of a flower are now considered as modified leaves. The calyx is often green, leafy, and indistinguishable from ordinary foliage. All gradations may be found between calyx and corolla. The bright color is no argument against petals being leaves, for leaves of the common sort often assume the most brilliant colorations. Other wild plants illustrate the transition from petals to stamens—as, for example, the flowers of the water-lilies; and pistils are frequently broad, green, and leaf-like, especially after the seeds are ripe, and the two infolded halves open out and take on the form and function of foliage.

We do not need to extend our examination upon this point in search of proof for the morphological significance of the floral

structures, but plants under cultivation sometimes throw off some of their disguises and give additional evidence of no mean importance. Just as the man under the influence of intoxicating liquor may reveal qualities of his nature that might have otherwise remained securely hidden, so the distortions seen in cultivated blossoms furnish a key which unlocks the secrets of normal structures.

The common garden lily (*Lilium tigrinum*) often has, instead of the six normal and similar parts to the perianth—the six stamens and a single tricarpellary ovary—first a multiplication of the petals and sepals, usually about twelve, followed (passing inward in the flower) by a number of petal-stamens or stamen-petals. The outer of these last have nearly lost their stamen characteristics, being broad, highly colored, spotted, and with only vestiges of anthers; while the inner ones are exceedingly irregular, and suggest that a severe struggle might have taken place between a hidden force that unimpeded would have made a petal, and another aiming to produce a stamen. In all such flowers there were no perfect stamens; however, some of the petal-stamens bore anther-lobes along their contorted edges, in which seemingly perfect pollen-grains were produced in quantity. The pistil in all these doubled flowers is an amalgamation of five or more carpels, but the tricarpellary type is not obliterated. In one instance a petaloid structure was observed, with ovules arranged along the mid-rib upon the upper side; while above the two widely separated edges were lines of chocolate color, characteristic of the anther-lobes. In another instance the perianth was reduced to a spathe-like structure, upon the inner veins of which were long double lines of ovules. Within this structure was a much misshapen pistil, compounded of at least six carpels, judging from the styles and sections made of the ovary.

In the ordinary case of doubling it is considered that a stamen is replaced by a petal, and the additional petals of the doubled flower are limited in number by that of the stamens. It is at once seen that this view does not hold with the lily; for, in place of the six normal stamens, there are at least twelve petals, only a few of the inner ones of which retain any marks of stamens. There is, therefore, an augmentation of the petals and transformation of the stamens. In the cultivated tulip the perianth is often increased to three or more times the normal number (six) of parts, and in one flower the modified stamens were found increased to nine. The pistil frequently shows signs of transforming into petals and becomes winged and bright-colored along one or more sutures, while the ovules are sometimes exposed to view between the separated valves.

The common garden pæonia is another large-flowered species,

but quite unlike the lily or tulip, because the stamens are very numerous in each blossom. In this plant there is no need of speculating as to the origin of the petals. They arise in large numbers from the failure of the stamens to develop as such. The filaments broaden out upon opposite sides and a petal results. In nearly half such petals the remnant of an anther can be seen at the tip of the petal, which is somewhat notched, often deeply, and in the center is the abortive anther. Near the center of the flower the transition is more evident, for here the filament-wings are not much broadened, and the anthers more prominent. Still nearer the great center pistil the ordinary stamens may be found, with their anthers bearing pollen. Occasionally the poppy illustrates a modification of the stamen in the opposite direction to that given above—namely, the inner ones become small simple pistils, which are either closely applied to the surface of the large central compound pistil, or adherent to it and blending with the stigmas.

The rose family and the crowfoots both furnish a long list of plants which uniformly produce double flowers under cultivation, and for this reason these two orders are rich in ornamental garden species. Both the roses and the buttercups abound in stamens; and, from what we have seen in the poppy, it should be expected that doubling would be easy in such plants. The examples of doubled flowers in these two families are so familiar that no further comment need be made. Among the hardy cultivated roses, for example, it is rarely that a blossom can be found not exhibiting all gradations between perfect stamens and unmistakable petals. It may, however, be stated that in a member of the rose family grown for its fruit—namely, the apple—petal-stamens were frequently met with. In the Tallman sweeting variety, upon one tree, the doubling was found as frequently as one flower in ten. Usually one stamen was transformed, but rarely so much so as to be distinctly petaline.

The abnormities which we have been considering, both generically and specifically, are rarely met with in wild plants in a state of nature. They are, therefore, transformations in flowers concomitant with culture. It is a well-established fact that culture induces changes in those parts for which the plant is cultivated and it might be added that they are cultivated because of this response. Varieties of any cereal differ mostly in the grain; beets, carrots, and turnips in the roots; apples, plums, and peaches in the fruit; and so on. In accordance with the general rule, plants grown for their flowers should vary most in the blossoms. A plant when under cultivation has been removed from the conditions which obtain in the wild state and is relieved from that fierce struggle for life which is everywhere in progress among

feral plants. In other words, the cultivated plant is living an unnatural existence; stimulated by man's careful attention and guided by his will, it yields to the demands of its guardian. Variations quickly arise under such fostering conditions, and such changes as are advantageous to man are, if possible, perpetuated by him. This perpetuity in many instances can only be accomplished by non-sexual methods, as by cuttings, graftings, etc., and it therefore follows that the seeding process is either ignored or prevailed against. With their energies all turned in some other channel, plants may in time cease to develop seed.

A flower of the showy sort we may consider as the product of two great forces or groups of forces—namely, that which is *within* the plant, and for the lack of a better term may be called the *constructive ability* of the plant; and those forces which act from *without*, and are included in the general term *environment*. The chief factor in this last or external force is the modifying influence of insects, due primarily to irritation. For example, the lily-flower in its wild state has reached its present condition because the mother plants and their insect attendants have worked together to produce a structure that is admirably adapted to the needs of each. It is, it seems to me, not asking too much of any one who is a disciple of evolution, even in its mildest form, to conceive that the simplest wind-fertilized flowers were the first of all floral structures to appear in the far-away geologic times. In those early ages, provided that we base our reasoning upon what is seen to-day, it is easy to understand that out of the foliar structures there were evolved the primitive ovary and the ante-Adamite stamen. That ancient ovary might stand in striking contrast with the simple pistil of a pine-cone or leaf serration of a cycas, and the corresponding stamen was perhaps only a slight modification of a common leaf. But out of these primitive essential organs came, by slow but by an ever-advancing adaptation to the surrounding world, the wonderful combinations of color, odor, and form which we see in the more complex floral structures of the present day.

All the conspicuous parts of the flower outside of the essential organs are for the purpose of securing a transfer of pollen from the stamen of one flower to the pistil of another. This process of cross-fertilization, as has been abundantly shown, is an advantage to the offspring, which are stronger and therefore better able to cope with surrounding rivals. Therefore, any change in floral structure, however slight, born of accident as some would say, or the result of an inward impulse to improve, is one step toward that ideal condition of perfect adaptation between a plant and its surroundings. So far as the sexual elements are concerned, this ideal adjustment seems to be that of wide separation, and accord-

ing to this view we find an explanation for the actual separation upon different plants of stamens and pistils in dicœcious species, in different flowers in moncœcious plants, and their practical separation in all cases when the stamens and pistils in perfect flowers mature at different times (dicogamy). Again, there is a long list of plants in which wide fertilization is secured by one flower having long stamens and short pistils, and another of the same species with short stamens and long pistils (dimorphism). Aside from all these well-defined plans for crossing, there are hundreds of others none the less obscure and often vastly more ingenious—plans so well worked out that the plant will fail to produce seeds unless a particular kind of insect visits it. All such species are constantly striving to arrive at a perfect adaptation between the flower and the peculiarities of its insect attendant. In short, the plan for wide fertilization is so thoroughly apparent along the many lines, that Darwin expressed the condition in the following concise and striking terms: "Nature abhors continual close fertilization."

The structure and form of the essential organs, like those of the floral envelopes, have come to their present condition through the prolonged interaction of plant and insect. Now, at the outset plants cultivated for their flowers were those already showy—that is, those in which the floral envelopes were conspicuous, fantastic, or sweet-scented. Let us bear in mind that these showy wild flowers became so in competition with hundreds of other species, and underwent all the expense of floral display for purely selfish ends. Each species worked out the problem of reproduction in its own way; and it is safe to assert that it became as much a part of the life of a wild rose to develop bright petals as to form compound leaves with large stipules.

In the historic development of such flowers it may be assumed that the essential organs came first, and the surrounding parts appeared and were preserved as they were found of service to the plant. As time went on, additional stamens and pistils may have been added, until the most economical number of parts was reached—if it has been reached. The number varies in many of the wild species to-day, and especially in those prominent in the flower-garden.

It is only fair to hold the successful floriculturist responsible for much of the seemingly stable increase of display in cultivated plants over their wild forms. This is the same credit that is freely given to the horticulturist who increases the size, for example, of the strawberry, by crossing, selection, etc., possibly at the expense of stamens, as seen in many of the pistillate sorts. By granting this there is no intention of overlooking the long-established tendency in the wild plant to develop

in the direction taken when placed under the favoring conditions of culture.

Garden plants illustrate with accelerated force the working of the universal law of compensation. Fruits not only enlarge, but become seedless. Therefore, the increase in the size and other modifications in the flowers of such plants as are grown for their blossoms is only in accordance with a general law. An augmentation of floral parts is only a step beyond the increase in size of parts already present, and may be largely a matter of convenience in the arrangement of the parts in the bud. When we remember that any augmentation in the petals, etc., would be seized upon by the gardener, and if possible reproduced, the wonder is that the increase is not greater than it is. It is not claimed that such an augmentation is a direct advantage to the plant, any more than is the exaggerated size of a cabbage-head or the thick, rich pulp of a grape, especially when the cabbage splits open and falls apart of its own weight, or the grape-pulp monopolizes the whole substance, and no seeds result. When the guiding hand of man is withdrawn, cultivated plants soon or late find their way back to a stable condition called the natural form, and are again able to cope with their neighbors, depending entirely upon the conditions attendant upon the wild state.

The point that now calls for our attention is the development of one floral organ out of another widely differing from it in appearance. Augmentation, we have seen, is to be expected, but metamorphosis usually brings surprise. The unnaturalness of this arises in part from the constancy of organs in wild plants, and the general impression that a manifest difference in structure and use must indicate dissimilar origin of the parts. All of the various organs of a flower are now, as before stated, generally considered as lateral outgrowths from the stem, and in a state of nature their number, size, shape, color, etc., depend upon the service of each in the economy of the plant. In origin and early growth, therefore, there is no microscopic difference between the sepals, petals, stamens, and pistils. As shown at the beginning of this paper, by taking the whole range of wild plants, it is not difficult to find all gradations, from the outermost sepal to the central pistil. If these various parts have a common origin—namely, in minute cellular outgrowths afterward connected with the primary axis by a vascular cord—the wonder is that each type is adhered to so closely in the wild forms, and the surprise should be that under the modifying conditions of culture more striking combinations are not found. The petals (that is, the inner whorl of floral envelopes) and the stamens (the outer circle of essential organs) form the boundaries between the two primary divisions of the complete flower. It is here that the line of separation is

most frequently broken, and especially in those flowers having an indefinite number of stamens and petals. In such plants in the wild state there is usually no established uniform number for either of these parts, and it may be that they vary as circumstances determine. In such cases it seems more natural to suppose that one gives place to the other, than that there is an independent development of a new part. However, when we come to the cultivated plants, this seeming chasm between petals and stamens is bridged, and the difficulty now turns upon deciding whether a certain organ is more or less stamen than petal.

As seen from both a physiological and morphological point of view, the pistil is considered the most highly differentiated part of the flower, the stamen next, petal next, and sepal least. Under the conditions obtaining with the cultivated rose, stamens are less important than petals, and probably less easily produced. Instead of the slender filament surmounted by the two lobes of the anther, bearing thousands of expensive pollen-grains, there is a broad, loose-celled, showy petal. When a stamen is replaced by a petal, it is naturally termed retrograde metamorphosis. In the rose, as in many other cultivated plants, all gradations may be found, from a normal stamen, with a slight color-line along one side of the slender filament, to the perfect petal, which may have a small notch at the tip, marking where the anther might have been. So long as the demand for self-propagation is met in other ways, the tendency to produce seed may be overcome, and the plant spends its energies in the formation of showy blossoms, possibly losing, for the time at least, the power to ripen seed. If the selective power of the rosarian is now withdrawn, while at the same time the stimulation of high culture remains, the inference is not unwarranted that the retrogression would continue so far that no flowers develop. It may be that the so-called green roses sometimes met with furnish solid ground for such a view. At any rate, they are forcible examples of the throwing off of floral disguises, and the true nature of the parts becomes evident to the most skeptical.

Rosaceous flowers furnish examples of the simplest form of doubling. In many others the struggle between the two forces seems to have been more violent, and the results are far from uniform, even in the same flower. In some species the broadening of the stamen takes place above the anther, as if the filament had become prolonged and petaloid. Frequently with such structures the rudimentary anther is at the base of the petal, or one half is midway upon one side, and the other opposite it, the connective having broadened out into the body of the petal. It is not unusual to find one half of the organ petaloid, while the other is contracted, contorted, and bears an anther-lobe containing fully

developed pollen. In the petunia the doubling of the flower is usually accompanied by a remarkable modification of the pistil —in short, a secondary flower is formed within the ovary. Botanists have long recognized an exceptional development of the floral axis which has been termed prolification. In this there may be a prolongation of the axis beyond the blossom, and the development upon it of ordinary foliage. The European larch furnishes a good illustration of this. Sometimes an ordinary leafy stem extends upward from the center of the cone for nearly a foot. In rare cases leafy branches have grown out from the free or blossom end of pears, and buds and long branches have arisen from the center of a rose. In the petunia this prolification, if we may call it such, assumes the form of a small and much-contorted flower. Repeated examinations of normal flowers fail to show any unusual structure to the pistil. It is, therefore, associated with the doubling process in the petunia. Instead of the end of the floral axis, which terminates at the base of the single centrally situated pistil, remaining as such, it develops into another flower, and this within the ovary of the primary blossom. Just why we should have this peculiar form of prolification, or any, in fact, is not for us to decide. The ordinary forces which would construct a normal flower have been thrown into confusion, and retrograde metamorphoses and floral prolification have resulted. In fact, it seems evident that out of the substance ordinarily producing a capsule of petunia-seed has been formed in the same ovary an amalgamation of stamens, petals, and a rudimentary pistil. In short, the tendency to petaline display does not stop with the stamens, but invades the pistil, and transforms it as already described.

After doubling has once become established, and the tendency is an hereditary trait, it still remains true that surrounding conditions may favor or modify it. It is well known that among wild plants the absence of favoring surroundings will hasten the period of reproduction, and even augment the yield of fruit. With doubled flowering plants it may be that they strive toward the same end, but fall short because of non-reproductive tendencies developed in them by long-continued culture for their showy flowers only.

A RELATIONSHIP between the flora of eastern Asia and of eastern North America was pointed out, as to Japan, by Dr. Asa Gray thirty years ago. It has been illustrated since by discoveries of new species alike in both regions, but they have been for the most part unimportant herbs. Greater force is now given to the fact by the discovery, by Dr. Augustine Henry, that the Chinese and American tulip-trees are identical. The discovery is significant in that it gives evidence that the climates of eastern America and of China have continued to be alike since the Tertiary period.

TELPHERAGE IN PRACTICAL USE.

By FREDERIK A. FERNALD.

A VAST field of application which electricity is only just entering upon is the transportation of freight and passengers. The use of electric motors for propelling passenger-cars on street railways may be said to have passed through the experimental stage into the domain of commerce. There are roads, using one or another of four or five different systems, in operation or in process of construction, in all parts of the United States, and new contracts are frequently being announced. Nothing, however, has been accomplished in this country in the direction of carrying freight by electricity. But a system, called "Telpherage," has been worked out in England, which is especially adapted to take the place of horses in carting, as they are already being displaced from the propelling of cars.

Telpherage may be regarded as a development of what is called in England the "wire-rope haulage" system, by which freight is conveyed in buckets suspended by a grip from an elevated wire cable. For distances of a few hundred feet, an inclined cable, down which loaded buckets suspended on traveling wheels move by their own weight, has also been used. The telpher system resulted from a union of the joint inventions of Profs. W. E. Ayrton and John Perry with those of Prof. Fleeming Jenkin. Prof. Jenkin had had in mind for some time the idea of propelling electrically a continuous stream of light trains without attendants along an elevated single rope or rail, which should be also the conductor of the electricity. He had not solved the problem of preventing automatically these trains from running into one another, when he read an account of the plan for dividing electrically the rubbed conductor of electric railways into sections, devised by Profs. Ayrton and Perry, and described by the former in a lecture at the Royal Institution, London, toward the close of 1882. This plan, designed to prevent leakage of electricity, also furnished an absolute block, cutting off the power automatically from any train whenever it approached too close to the one in front of it. At Prof. Jenkin's suggestion, a partnership was entered into by these three gentlemen, and "The Telpherage Company" was soon afterward formed, to bring their system into practical use. Experimental work was carried on for over two years on the estate of Mr. Melton R. Pryor, the chairman of the company.

Various details of construction were worked out in these experiments, and at the beginning of 1885 the scheme was sufficiently developed to be put in practical operation. Arrangements

were made with the Sussex Portland Cement Company for building a telpher line to carry clay from the clay-pits on Lord Hampden's estate at Glynde, in Sussex, to the Glynde Railway station. While this work was in progress, Prof. Jenkin died, and was succeeded as engineer of the Telpherage Company by Prof. Perry, under whose direction the line was completed. It was put in operation October 17, 1885. The general appearance of the Glynde telpher line is shown in Fig. 1, and the following description of it

FIG. 1.—PART OF THE TELPHER LINE AT GLYNDE.

is based upon lectures delivered by Prof. Jenkin and Prof. Perry. The structure consists of a line of posts, eighteen feet high and sixty-six feet apart, with cross-heads eight feet long at the top. Instead of a cable, as used in the wire-rope haulage system, it was found better to have round steel rods, three quarters of an inch thick, running from post to post for the buckets, or "skeps," to travel on. The ends of the rods are fastened to cast-iron saddles. As the train of skeps runs on a single rail, a double track, or two lines of rods, can be supported at the two ends of the cross-heads on the single line of posts. As would be expected, these slender rods sag somewhat under the weight of the loaded skeps, but the trains are made of the length either of one span or two spans, so that the part of the train coming up out of the depression is helped on by the weight of the part just going down into it. The sagging makes the mechanical resistance but little more than is experienced in hauling a train of the same weight along a rigid track, while the use of flexible rods enables the road to be built

much more lightly and hence much more cheaply than if stiff rails were used. On curves, sidings, and sections for loading and unloading, however, it is found better to employ the stiff rails, which are supported by posts thirteen feet apart. The form of

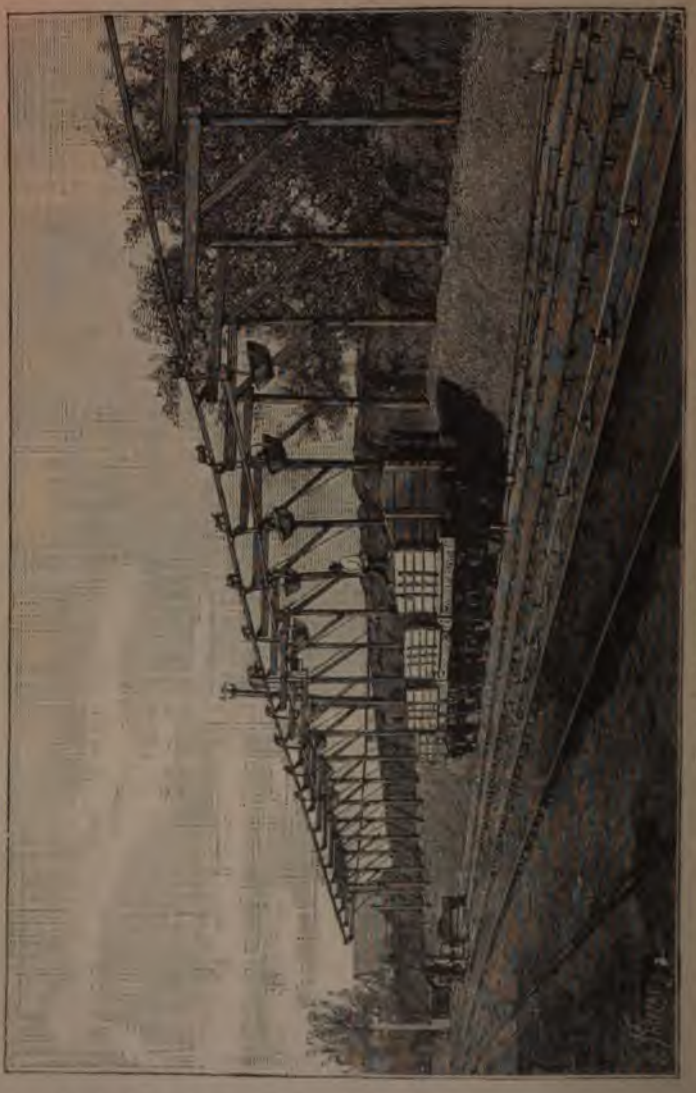

FIG. 2.—A TELPHER TRAIN AT THE RAILWAY SIDING.

switch which has been devised for telpher lines consists of a hinged stiff blade of steel, which allows a train to run off on to a stiff siding, when it is lowered so as to rest on the main line.

At intervals along the line straining-posts are placed, each of which acts as an abutment for a number of spans on one side, and carries a compensation gear, by which an equal number of spans

on the other side are kept up to the proper tension. The compensation gear consists of a chain attached to the end of a rod, which here is not bolted to the saddle, and running down to a lever and weight beneath the track. These gears keep the tension of the rods uniform in spite of varying loads and temperature; on the line at Glynde the tension is two and a quarter tons. While this line was being constructed, Prof. Perry discovered that the tension of a rod could be determined very simply, by setting it to vibrating, and counting the vibrations in a quarter of a minute.

A train on the Glynde line consists of an electric locomotive and either five or ten skeps, in the latter case the locomotive being in the middle of the train. The skeps, are spaced evenly and somewhat widely apart, being connected by poles fourteen feet long, in order to distribute the weight of the loaded train over a considerable length of the rail, which allows the track to be light and correspondingly cheap, and in order also to have the train of the proper length to make the necessary electrical connections as it passes from span to span. The poles are attached to the buckets by a hook-and-eye coupling, easily detached. Each skep weighs one hundred and one pounds, and holds about two hundred and fifty pounds of dry clay. The cross-piece connecting the two wheels is of wood, so that the bucket, being suspended from this by a hanger, is insulated from the line, and may be handled without any shock being felt. An empty train at Glynde will travel to the clay-field where the track slopes down so as to bring the skeps nearly to the level of the ground. A laborer touches a key and stops the train, the skeps are then filled, the key is touched again, and the train starts off.

At the railway siding the train does not stop. The buckets pass above the middle of the cars, into which the clay is dumped automatically by the handle at the bottom of each bucket striking an arm projecting from a post. Any kind of a load, such as bags of grain or logs, may be hung from the hangers by replacing the buckets by bands, or a seat holding two passengers may be substituted for the bucket, which would allow of twenty passengers being drawn by one locomotive. For passenger lines, however, Prof. Perry says that it would be found probably more convenient to use a stiff rail rather than the flexible rod. A *single-wheeled* skep, suggested by Mr. Horace Darwin, has been given practical form by Mr. Gordon Wigan. A train of these skeps moves with less friction and is more flexible, so that it goes round curves more readily than a train of the two-wheeled skeps. Mr. Wigan has also designed a one-wheeled locomotive.

An end view of the "tandem locomotive," which is the form used at Glynde, is shown in Fig. 3.

This consists of a Reckenzaun motor, with the necessary gear-

ing, driving-wheels, etc. The locomotive is suspended by two wheels, Q, which have rubber tires. The electrical current passing through the motor drives it at the rate of sixteen hundred to seventeen hundred revolutions a minute, and the power is transmitted by the cog-wheels A and B to a second horizontal shaft on which is a chain-wheel, F. A chain going round this wheel, and round two chain-wheels at C, C, causes the two driving-wheels of the locomotive to rotate.

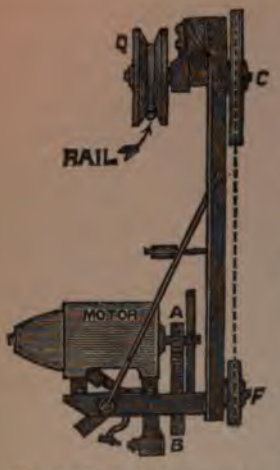

FIG. 3.—TANDEM LOCOMOTIVE (end view).

Various forms of grip and friction-gearing locomotives have been devised by the staff of the Telpherage Company, but it was found that the simple locomotive represented in the figure could go quite readily up inclines as steep as one foot rise in thirteen; no grades so steep as this were needed at Glynde, hence the more elaborate machines were not put in use there. Prof. Perry is confident that the simple locomotive would be effective on grades as steep as one in ten, if the rail be kept quite dry. It was found that the weight of the locomotive, which is not much greater than that of one of the loaded skeps, with the aid of the rubber tires produces enough friction on the rail for the propulsion of the train. In the wet season of the year the rubber tires will last only a fortnight, but in dry weather their life is much longer. Still, even on the wettest days the locomotive performs its work quite well.

It was feared at first that trains near the engine-house would move much faster than those which were farther away. But this difficulty is prevented by an electrical governor attached to each locomotive. In Fig. 4, D is the second shaft, and W W are the two weights of a centrifugal governor, which are held ordinarily in position near the axis by means of the spring S. When the weights fly apart to the dotted positions W′ and W′, they draw the lever into the dotted position and break the metallic contacts at *c*, so that no electricity can be received by the motor. But no spark is made at *c*, because, after the contact is broken there, a connection of small resistance is continued for a short time at *a*, between two carbons, or a piece of carbon and a piece of iron, one of which is compelled by a spring to follow the other for some distance. If the contact be suddenly broken when the motor is making seventeen hundred revolutions a minute, the electric current will remain cut off until the speed of the motor has become reduced to about fifteen hundred. The position of the governor on the

locomotive may be seen in Fig. 3, under the motor. While ascending a steep grade the current will be on for almost the whole time; while descending such a grade it will be off altogether; on level stretches it may be on for, say, a quarter of the whole time of running. This plan avoids all waste in switches or interposed resistances, and the current cut off by each governor is too small to injure the dynamo.

But since a train when going down a steep incline is liable to get up too great a speed, even without its motor receiving any

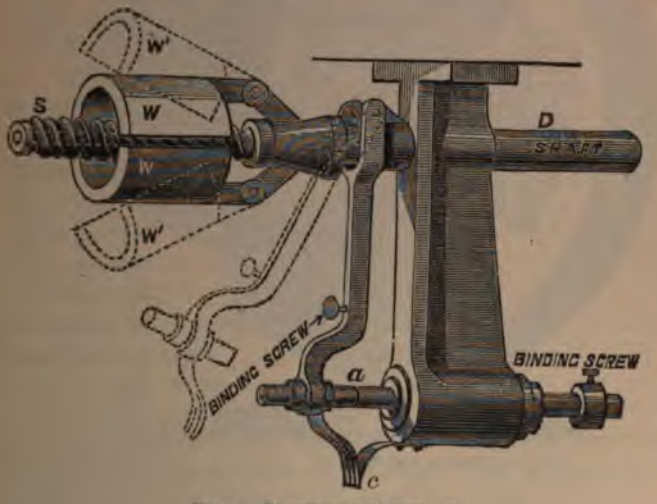

FIG. 4.—ELECTRICAL GOVERNOR.

electricity, the locomotive is provided also with a brake, shown in Fig. 5. This is placed on the shaft of the motor, and the edge of it may be seen in Fig. 3, beside the cog-wheel A. In Fig. 5, W W are two weights whose centrifugal force, up to a speed of eighteen hundred revolutions of the shaft A per minute, is balanced by the springs S S, but above that speed the weights draw outward and press the wooden brake-blocks B B against the metal ring C, which is fixed to the frame of the locomotive, thus retarding the motion of the train.

The method of working telpher trains employed at Glynde is what the inventors call the "Cross-over Parallel System." Fig. 6 is a diagram showing the electrical connections according to this system, where an up and a down track are used. Each track is divided into sections, each span of the ordinary length being a section. Alternate sections of each track, A_1, B_1, A_2, B_4, etc., are electrically connected together and to one pole of the generator of electricity D; the other sections are also connected together, and to the other pole of the generator. The two sets are well insulated from each other. Only two wheels of a train are employed

for making contact, and these wheels are just the length of a section apart. When the leading wheel L is on a negative section, as A_3, the trailing wheel T is on a positive section, A_1, and *vice versa*, so that a circuit is made between the poles of the generator through the rails, the two contact wheels of a train, and a wire connecting these wheels through the motor M on the locomotive, which thus receives its supply of electric energy. Of course, the current through the motor is stopped and reversed each time the contact wheels pass from a positive to a negative or a negative to a positive section, but this makes no difference with the direction in which the motor runs, nor does it injure the dynamo. We can cause the locomotive to run backward, however, by altering the positions of the commutator-brushes on the motor. In the case of a single track, the positive sections A_1, A_3, etc., would have to

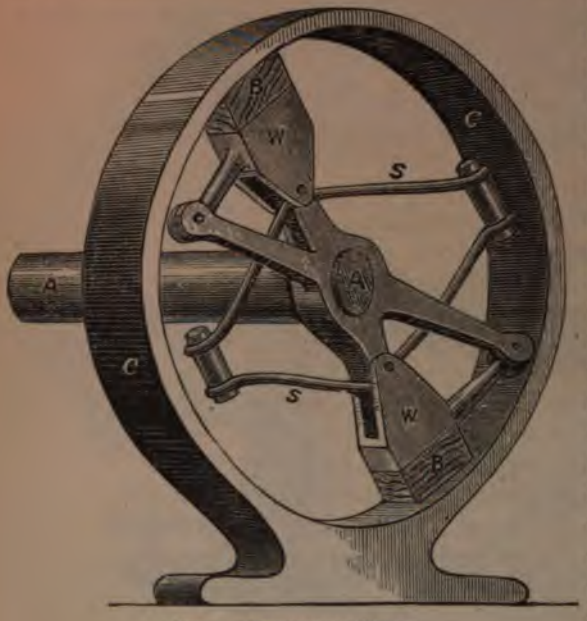

FIG. 5.—MECHANICAL BRAKE.

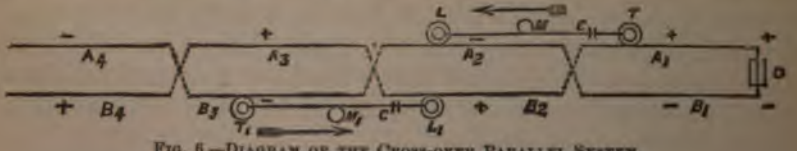

FIG. 6.—DIAGRAM OF THE CROSS-OVER PARALLEL SYSTEM.

be connected by a long wire instead of through the sections of rail B_2, B_4, etc. This system requires that the sections shall all be of equal length, which is sometimes inconvenient, as when broad gorges have to be crossed, and at curved parts of the line. But this difficulty can be overcome to some extent by employing a "gravitation section" longer than the distance between the contact wheels of a train. This section is constructed with a downward slope, so that the weight of the train will propel it over the part in which it receives no electric energy.

Fig. 7 shows how the ends of the steel rods are fastened and insulated from each other. The end of one rod is turned down and fastened to the cast-iron saddle with a nut, as shown at the right of the figure. The end of the next rod, A, is bolted to the cast-steel cap C, which is insulated from the saddle by an insulator of vulcanite, V; and, in order that the tension of the rods may not break the vulcanite, melted lead is run in between the

FIG. 7.—ORDINARY SADDLE.

saddle and the insulator, and between the insulator and the cap. To prevent the metallic wheels of the skeps from short-circuiting the two sections as they cross the tops of the posts, there are insulated gap-pieces, as shown in this figure, on the saddles between each rod and the next.

Each of the motors at Glynde receives a power of about fifteen hundred watts, or about two horse-power, and as the potential is about two hundred volts everywhere on the line, each motor receives about eight ampères when a train is running at about four and a half miles an hour. The dynamo used on this line is a Crompton six-unit "shunt-wound" machine of the Gramme type driven by a steam-engine. It is evident that a telpher line could be run with water-power, where this is available, even if the source of power is several miles from the track.

The line at Glynde is a little under a mile in length. On long lines it is expected that a source of power would be needed every ten miles, working the trains for five miles in each direction.

The advantages claimed for telpher lines over surface railroads using steam locomotives are, first, the much less cost of the road and equipment. Thus, as the result of the experience gained in constructing the Glynde line, it was estimated that a similar line could be erected for a total cost equal to about six thousand dollars, including engine, dynamo, track, and five trains, with

locomotives to carry one hundred tons a day. Where rivers and gorges have to be crossed and very uneven ground is to be passed over, no expensive bridging or grading has to be done. It is not necessary to buy the land over which the line runs; only a right of way need be acquired—for the tracks being elevated, the road does not interfere with the use of the ground for agricultural or other purposes. At Glynde this consideration was an important one, and the fact of the tracks being elevated was also important for the reason that sometimes in winter some of the fields over which the line passes are several feet deep in water. The presence of an electric line of conveyance may be an actual convenience for agricultural operations; for a root-cutter, a shearing-machine, a thrashing-machine, a circular saw, or any other agricultural machinery, may be driven by attaching a small electro-motor to the machine, and connecting it by wires with the rods of the line.

A train of ten loaded skeps, on a road of flexible rods such as has just been described, weighs about two tons, yet lines can be designed, especially when stiff rails are used, that will carry almost as heavy loads as desired. Yet telpher lines are especially applicable where the traffic is not large enough, or the difficulties of construction are too great, to make an ordinary railroad profitable, and where the goods would be conveyed in carts or on pack-horses. Prof. Perry estimates that on a railway the cost of transporting freight is about 1*d.* per ton per mile, if there is a sufficient amount of traffic; that on a telpher line the cost is from 2½*d.* per ton mile to 3½*d.*; whereas cartage can not be performed at much less than 1*s.* per ton mile, and even at this high price the cost of constructing the cart-road and keeping it in repair is left out of account. Telpherage is claimed to be superior to the wire-rope haulage system in its power to turn sharp corners with ease.

It was reported in the spring of last year that the Glynde line had given every satisfaction under continuous working for over three years, and that negotiations were in progress for the erection of telpher lines both in England and abroad. Among the contracts then recently made was one for two lines in Cornwall, for the carriage respectively of one thousand and five hundred tons of tin ore a week.

In regard to possible applications of telpherage Prof. Perry has said: "As we have it at present, it will not only be very useful in bringing ore from mines, but it is easy to arrange for a telpher line which will load or unload a vessel which is unable to come close to shore on account of the shallowness of the water, and we can imagine these trains of skeps running out over the sea, running down into the hold of a vessel, running up again, and

coming back to land. . . . We have at present very modest aims. I should prefer for some time to simply develop lines like the one at Glynde; but I am quite sure that in future, when more capital than we have had at our command is employed to develop the system, we shall have trains of skeps passing down empty into coal-mines and along the workings, to be filled by the men as they dig the coal from the face, coming back to the bottom of the pit, and, moving up a vertical rod, passing on to the ordinary lines at the surface, and then without stopping, except perhaps to be labeled, traveling along, shunted from point to point by men properly stationed, who will know what to do with each train by the ticket upon it, until they will eventually reach the door of the customer who is to use the coal. The immense amount of worry which there has been in the development of telpherage, even as we now see it, shows me that its grandest developments can not come in my own time; but that it must come in the long run; and that telpherage will be a general system of distribution of goods is a fact which is fixed in my mind so securely that no amount of disappointment or worry can remove it."

THE COMMERCIAL GEOGRAPHY OF SOUTH AMERICA.*

By GEORGE G. CHISHOLM, F. R. G. S.

THIS, the smaller half of the New World, has at least four fifths of its area within the tropics, and hence yields chiefly tropical products; but here as elsewhere the temperate area, relatively to its extent, furnishes a greater abundance of commercial commodities, and it is in this part of the continent that the rate of increase in the production of such commodities, and the development of means of distribution for them, are now most rapid, and European immigration is most constant.

The lofty chains of the Andes, on the west side of the continent, form an important climatic barrier. In the latitudes in which the trade winds prevail they arrest the moisture-laden winds from the Atlantic, draining the moisture out of winds that had already been partly drained in their course over the continent farther east. The Andes also constitute a great obstacle to communication between the east and west coasts. There is as yet no railway that completely crosses any part of them, though there are railways which reach a height of upward of fourteen thousand feet before attaining the table-lands between the principal chains of these mountains.

* From the author's Handbook of Commercial Geography, recently published by Longmans, Green & Co., London and New York.

Some of the mighty rivers to the east of the Andes form excellent water-ways. The Orinoco, in the north of the continent, is navigable for steamers continuously for nearly a thousand miles. The Amazon is navigable without interruption to the base of the Andes, a distance of twenty-six hundred miles from its mouth, and six thousand miles of navigation are afforded by the main stream and its tributaries. Many of these tributaries, however, have their navigable course greatly obstructed by falls and rapids. The value of the navigation of the Amazon is diminished by the paucity of population and products in the region through which it flows and by the similarity of the products in nearly the whole of its navigable course. The inland water-way, which is already of most importance, and likely to remain most useful to commerce in the future, is that from north to south formed by the upper Paraguay and the lower Parana, a water-way which is uninterrupted from near the source of the former river, and which, like the Mississippi, brings hot and temperate climates into direct communication. Its chief drawback is the extreme shallowness of its estuary, the Rio de la Plata, or River Plate.

The population is still very scanty, probably not more than thirty millions. Whites of pure blood form only from two to three tenths of the whole, negroes about one tenth, and the remainder either native Indians or people of mixed race; so that on the whole the Indian element still largely predominates. The white population in Brazil is of Portuguese origin, and Portuguese is there the official language; but elsewhere, except in Guiana, the whites are mainly of Spanish descent, and Spanish is the official language.

Brazil is an empire* which secured its independence of Portugal in 1822. In size it is the rival of the United States and Canada. Only a limited area has been turned to account for agriculture. Even the area which travelers in Brazil deem it possible to bring under cultivation at some future time is but a small fraction of the whole. The equatorial valley of the Amazon is filled with dense forests. Close to the coast, that trends in a southeasterly direction, stretch ranges of mountains which cut off the Atlantic moisture from the region behind. This region is made up mainly of low table-lands (*campos*) with a sterile soil. North of about 20° south—that is, throughout the broader part of the country south of the forests—these *campos* are considered fit for nothing but pasture. There remains nevertheless an area in the south—small, indeed, compared with the extent of the empire, but yet between four and five times the size of Great Britain—in which there are many fertile districts still unsettled, and a considerable

* [These pages were written before Brazil became a republic.—Editor.]

extent of these in latitudes fit for European settlers. Till recently the practice of slavery has deterred free immigrants from settling in those provinces in which the institution was most firmly established (those growing tropical products), but since 1871 it has been in process of abolition, and it was entirely abolished in 1888. Great efforts are hence being made by the Brazilian Government to attract immigrants to those districts in which a substitute for slave-labor is most needed. Immigrants, chiefly Italian and Portuguese, are now arriving in thousands. In the southernmost provinces, where slavery was never very general, German and Italian colonies have existed for many years. Railways are so far most numerous in the coffee region of Brazil. Of the projected railways, one of the most important is that designed to avoid the rapids of the Madeira, but for which steamers would be able to ascend to the base of the Bolivian table-land.

The capital of the empire is Rio Janeiro, which is also the chief seaport, and the principal outlet for the coffee region. Its harbor is admirable on account of its commodiousness and safety, and delightful on account of its beauty. The second port of this region is Santos, farther south. Bahia, or San Salvador, and Pernambuco are the seaports of the region producing sugar, cotton, and tobacco; Para, Maranham, and Ceara, those of the region yielding forest products — rubber, Brazil-nuts, cabinet and dye woods, together with cacao and sugar. The ports of the temperate region producing animal products are Rio Grande do Sul, Pelotas, and Porto Alegre, all of which are accessible only to vessels of small draught (under eleven feet), on account of a bar at the entrance to the shallow lake on which they all stand.

Colonial Guiana consists of three portions—one British, about equal to Great Britain in size; one Dutch (Surinam); and one French (Cayenne). Cultivation of plantation products (chiefly sugar-cane) is almost confined to the British and Dutch colonies, and in these to a strip of lowlands along the coast and the river-banks—a strip partly below sea-level, and protected by embankments. In British Guiana Demerara is the chief sugar district. The laborers are negroes, mulattoes, and coolies. In British Guiana a rich gold-field lies on the banks of the Cuyuni in the west, but it has long remained unworked on account of claims being made to this portion of the territory by the government of Venezuela. A rich gold-field is reported to have been recently discovered on the borders of Dutch and French territory. Cayenne is used by the French as a place of deportation for Arab convicts from Algeria.

Venezuela, a republic in the north of the continent, consists chiefly of the basin of the Orinoco. People of Spanish, Indian, and negro descent, all now free, make up the bulk of the popula-

tion; and the majority are settled on a small area of highland valleys in the northwest, where branches of the Andes strike northeastward, and then eastward parallel to the coast. The staple product is coffee; but cacao, cotton, tobacco, and sugar, besides other tropical products, are grown. Gold in the east and copper in the west are important minerals. The plains (*llanos*) of the Orinoco are devoted to cattle and horse rearing, an industry at one time much more flourishing than now. The chief inland towns are Carácas (the capital) and Valencia, which are situated in inland valleys from eighteen hundred to three thousand feet in height, and are connected by rail with their respective seaports, La Guayra and Porto (Puerto) Cabello. Ciudad Bolivar, on the Orinoco, the navigation of which is free to all nations, may also be ranked as a seaport, being accessible to sea-going vessels.

Colombia is a republic with a similar population to that of Venezuela, settled chiefly in the upper parts of the valleys of the Cauca and Magdalena, where, in consequence of the great elevation, the grains of temperate climates are grown. In the lowlands, on the other hand, rice is grown; and it is so generally eaten by the people that a deficiency of this commodity has to be made up for by import. The mineral wealth is great, and gold, silver, and precious stones take a leading place among the exports, which include also Peruvian bark and plantation products. The great channel of communication is the Magdalena, which is navigable for steamers without interruption as high as Honda, but on account of a bar at its mouth is connected with the sea by a short canal running westward to Cartagena, and a railway from Barranquilla to another seaport nearer the mouth of the river. The Panama Railway (from Colon or Aspinwall in the north to Panama in the south) and the Panama Canal belong to Colombian territory. Bogota, the capital, is within five degrees of the equator, but, in virtue of its situation at the height of eight thousand feet above sea-level, enjoys a healthy climate, with a temperature like that of a perpetual spring.

Ecuador is a republic chiefly south of the equator, but which owes its name to the fact that its capital, Quito, is almost under that line. Quito lies, like Bogota, between two chains of the Andes, its elevation being between nine and ten thousand feet. The only seaport is Guayaquil, whence cacao, grown on the western lowlands, is exported. At present communication is difficult between Guayaquil and the capital, but a railway between the two towns is now in progress. To Ecuador belong also the Galápagos, or Turtle Islands, a group situated on the equator, about seven hundred miles to the west.

Peru, a republic lying to the south of Ecuador, has a popula-

tion of about three millions, at least half of whom are pure Indians. It is composed of three zones: 1. A rainless coast strip, fertilized only here and there by rivers from the Andes, which afford the means of irrigation for sugar and cotton plantations tended by Chinese coolies. 2. The sierra, or valleys and table-lands of the Andes. On one of the table-lands lies (partly in Bolivia) Lake Titicaca, the largest lake in South America, at the height of twelve thousand five hundred feet above the sea. At this height even barley seldom ripens, and the only regular food-grain is derived from a native plant called *quinoa* (wholly unlike our cereals). 3. The Montaña, the region on the eastern slopes of the Andes, containing the head-waters of the Amazon, a region largely covered with impenetrable forests, of which the most valuable product is Peruvian bark. The capital of the country is Lima, an unhealthy city on the coast strip, a few miles from its port, Callao.

The chief exports are sugar, cotton, nitrate of soda, and llama, vicuña, and sheep's wool; the first three derived from the coast strip, the last from the sierra. Apart from nitrate of soda, the mineral wealth for which Peru (including Bolivia or Upper Peru) was long ago noted is at present commercially of little importance, but projects are now on foot for conferring renewed importance on them by the laying of railways. Among the railways already in existence in Peru are two of the most remarkable in the world, those namely by which the table-lands of the Andes are reached. One of these is the Lima-Oroya Railway (not yet completed), which attains in its passage through the western chain of the Andes a height of fifteen thousand six hundred feet. This railway it is proposed to continue northward to Cerro de Pasco, where there are immense deposits of silver-ore, though the silver-mines have been inundated for half a century. These it is proposed to reopen and work scientifically. The other Andes railway is from the southern seaport of Mollendo to Puno on Lake Titicaca, and this line it is now proposed to continue northward to Cuzco, the ancient capital of Peru. The value of this line has already been greatly increased by the establishment of steamboat traffic on Lake Titicaca and the river Desaguadero, the outlet connecting that lake with Lake Aullagas in Bolivia. Another railway project which has the prospect of being carried out is one for a line southward from Lima, to be afterward continued up the Andes to Huancavelica, where there are rich deposits of quicksilver. It is likewise proposed to bring the Montaña, now almost completely shut off from external commerce, into connection with the outside world by the laying of roads in the north to the Amazon. In this district cotton and coffee plantations have already been started with success.

Bolivia is a republic, now entirely inland, occupying the broadest part of the table-land of the Andes, with a montaña to the east. Its population is about two millions, inclusive of about eight hundred thousand uncivilized Indians. Even the civilized population is mainly of Indian origin. The communications of Bolivia with Peru and Brazil have already been referred to. The capital of the country is Sucre, on the part of the table-land drained to the east. La Paz is the chief town on the table-land of Lake Titicaca. The silver-mines of Potosi, which made Peru so valuable a possession to the Spaniards, belong to this state, and are still productive, though in a greatly diminished degree.

Chili, a republic, possesses the whole of the coast strip south of Peru, together with the islands that fringe the coast, including part of Tierra del Fuego and both sides of the Strait of Magellan except in the extreme east. The northern portion of the country is a continuation of the desert strip on the coast of Peru, and is valuable solely for its mineral products—guano (near the coast from the frontier to about 21½° south), nitrate of soda, or cubic niter, as it is also called (in the same latitudes, but farther inland), gold, silver, and copper. Copper is even more abundant farther south, along the base of the Andes, north and south of Coquimbo. Silver is also found more abundantly to the south of Copiapo. The middle portion of the territory (between about 33° and 38° south) contains the bulk of the population, who number about two million five hundred thousand in all. The agricultural products are mainly wheat, barley, and southern fruits—similar, in fact, to those of Spain, which has a climate resembling that of the more populous parts of Chili. Notwithstanding that whites predominate in this republic (instead of Indians and half-breeds as in most of the others), agriculture here also is generally in a backward condition, except in some parts of the north, where there are some admirable irrigation works. In the more thickly peopled part of the country there are several hundred miles of railway.

The capital of the country is Santiago, and its port is Valparaiso, on a fine bay looking to the north. Here is received the great bulk of the imports, but since the greater part of the exports consists of mineral produce, chiefly nitrate of soda, copper, and guano, the northern port of Iquique, whence most of the nitrate and guano is shipped, has the largest share in the export trade, Valparaiso coming only second, and Pisagua (another northern port) and Coquimbo next in order. Next to minerals wheat and other agricultural produce form the chief exports. The leading imports are manufactured articles, coal, and iron. The United Kingdom receives the bulk of the exports, and takes the first place in the import trade, Germany and France following,

and contributing together a share about equal to that of Great Britain. There is a considerable import trade in cattle and other animals from the Argentine Republic across the passes of the Andes, but the export trade by these routes is very scanty. The passes chiefly used are those near the latitude of Santiago, the Portillo and the Uspallata passes—the former nearly fourteen thousand feet in height, the latter about five hundred feet less. The Strait of Magellan is stormy and washed by strong tides, and hence difficult of navigation, so that sailing vessels still prefer the equally stormy, but for them less dangerous, route round Cape Horn, in the south of Tierra del Fuego.

The Argentine Republic comprises a territory of more than a million square miles, with a population of about four millions. This territory consists mainly of a vast plain sloping down to the Atlantic from the Andes, and other lofty mountains in the west and northwest. It extends from within the tropics to the south of the continent, embracing the eastern half of Tierra del Fuego, and thus includes a great variety of climate. The districts in which the population is most considerable and most rapidly increasing are chiefly those in the neighborhood of the estuary of La Plata and along the right bank of the lower Parana, where there are not only the greatest facilities for commerce, but where also the climate is most favorable to production and best suited to people of European stock. The provinces to which this description applies are Buenos Ayres, south of the estuary; Santa Fé, on the right bank of the lower Parana; Cordoba, to the west of Santa Fé; and Entre Rios, "between the rivers" Parana and Uruguay. The climate here is that of the warmer temperate latitudes, generally with an ample rainfall. Toward the interior the rainfall generally diminishes, and irrigation becomes necessary for cultivation. It is more abundant, however, in the neighborhood of the northern mountains, at the base of which there are sugar and other tropical or sub-tropical plantations. The plain extending eastward from these mountains to the river Paraguay is mainly a region of open forest, and is inhabited at present almost solely by a few tribes of wandering Indians. It is known as El Gran Chaco, or "great hunting-ground."

Of late years the Argentine Republic, together with the neighboring state of Uruguay, has been undergoing a rapid development similar to that of the United States and Canada. They are receiving streams of agricultural settlers, but in this southern region the settlers are mainly from southern Europe (Italy, Spain, and southern France). The Spanish and French immigrants include a large proportion of Basques, who are found to be among the most valuable colonists in these regions. In the thirty years ending 1886 upward of a million immigrants entered the country,

and in each of the three years 1886 to 1888 the number considerably exceeded one hundred thousand. The branch of agriculture mostly pursued by these immigrants is not tillage, as in the northern region of European immigration, but the rearing of live stock (chiefly sheep and cattle). Tillage, however, is receiving greater attention, especially in the agricultural colonies, which have been planted in large numbers since 1856, principally along the banks of the Parana; and the result of this is seen in the rising export of wheat and maize. The cultivation of maize is not at present nearly so extensive as the climate of the settled districts admits of, which is chiefly due to the want of a market for the produce; but there is reason to believe that its cultivation might be profitably stimulated by the establishment of the "pork-packing" industry on the same basis as in the United States.

The chief export is wool. The natural facilities for inland commerce afforded by the Paraguay and lower Parana have been mentioned; and here it may be added sea-going vessels can ascend the Parana to Rosario, that the Parana is likewise navigable for steamers above the confluence of the Paraguay as far as the limit of the Argentine frontier, that steamers can ascend the Uruguay River on the eastern frontier as far as the falls which occur in about 31½° south (at the Urugayan town of Salto), and that sea-going vessels of fourteen or fifteen feet draught can reach as high as the Uruguayan town of Paysandu. The Pilcomayo, on the northern frontier, is navigable for two hundred and forty miles, and the Rio Negro in the north of Patagonia affords three hundred miles of navigation through a region deemed a few years ago scarcely fit for settlement, but which is now being rapidly stocked and settled along the whole course of the river. Patagonia, the territory south of the Rio Negro, is mainly a stony desert, but recent explorations have shown that it embraces a considerable amount of fertile land along the base of the Andes. On the coast of this territory there has long been a Welsh colony at Chubut, in latitude 43°, where, among other things, wheat is grown.

As in the United States, railways are being rapidly extended to promote the commerce on which the immigration depends. The Argentine Republic is the part of South America in which railway construction has been, and still is, most active. There are projects for no less than three railways across the Andes into Chili. Of these the farthest advanced is the continuation of the railway from Buenos Ayres to Mendoza across the Uspallata Pass.

The capital of the republic is Buenos Ayres, which stands on the River Plate, and is at the same time the chief seaport, carrying on about one third of the shipping of the republic. This proportion would probably be larger if it were not for the defective-

ness of the port, which is one of the chief hindrances to the development of Argentine commerce. At present, in consequence of the rapid silting up of the River Plate, large vessels have to anchor ten miles from the city, and have not only to load and unload with the aid of lighters, but in certain states of the river large-wheeled carts have to be employed to convey goods and passengers from the lighters to the wharves. Great harbor-works are now, however, in progress with the view of providing a navigable channel to large docks that are to be constructed close beside the town. Lower down the estuary a new capital for the province of Buenos Ayres has been founded under the name of La Plata, and a port with docks and a navigable channel nowhere less than twenty-one feet in depth has here been provided.

Uruguay, a republic lying between the estuary of the La Plata and Brazil, has a similar surface, climate, and population, and similar industries to the neighboring provinces of the Argentine Republic, and is now being as rapidly developed. Among the railways there is one avoiding the rapids of the Uruguay River above Salto, and there is one in progress connecting Salto with the capital. Having a greater rainfall on the whole than the more populous districts of the Argentine Republic, Uruguay rears relatively to area more cattle than the latter country; and of the one million two hundred thousand animals that were annually slaughtered in the two republics for the making of preparations of meat, on the average of the ten years 1876–1885, about fifty-five per cent were slaughtered in Uruguay. This industry has made the small towns of Fray Bentos and Paysandu, on the Uruguay, well known throughout Europe. Among the countries sharing in the commerce of Uruguay, the United Kingdom has the first place both in imports and exports, supplying on the average of the years 1878–1885 nearly twenty-nine per cent in value of the imports, and receiving about twenty per cent of the exports. The capital of Uruguay is Montevideo, which has an excellent harbor.

Paraguay is an inland republic, lying mainly between the Paraguay and Parana Rivers, with a very sparse population, chiefly of native Indians. Its chief export product is the so-called Paraguay tea, or *maté*. Tobacco, timber, and skins are also exported.

The Falkland Islands, situated to the east of the Strait of Magellan, belong to the British. They have a damp, foggy climate, and are largely covered with peat, but are inhabited by a small number of settlers engaged in the rearing of sheep and cattle. They are frequently visited for repairs and supplies by vessels that have made the passage round Cape Horn.

SKETCH OF MATTHEW FONTAINE MAURY.

MRS. CORBIN, Lieutenant Maury's daughter and biographer, invokes for her father the reverence of the whole civilized world; for, she says in her Life, "the best part of his life was devoted to the performance of services which conferred benefits on the seafaring class of all countries, while the ideas to which he first gave birth have since borne fruit, and are likely to be useful to the whole human race." She adds that "in Maury we have two characteristics, each valuable in itself, but which almost invariably produce great results when they are combined. He was endowed with extraordinary powers of application and unflagging industry in working out the driest details. But he also possessed a vivid imagination, so that the dry bones of his new science were endowed with life and interest by the magic touch of his descriptive pen. It was Maury who created the science of the physical geography of the sea, and gave that impetus to its study which, in other hands, continues to produce results alike of practical and speculative importance."

MATTHEW FONTAINE MAURY was born in Spottsylvania County, Virginia, January 24, 1806, and died in Lexington, Va., February 1, 1873. He was descended on his father's side from two families of Huguenot exiles, already connected by marriage before they left France, who settled in Virginia in 1714. His father was the sixth son of the Rev. James Maury, an Episcopal clergyman and teacher of Albemarle County, Virginia, who numbered among his pupils three boys who afterward became Presidents of the United States, and five signers of the Declaration of Independence. This scholar appears to have been already interested in the great Northwest, and his speculations respecting the Missouri River, the Western mountains, and the rivers beyond them, then hardly known, greatly impressed his pupil Jefferson, who, when he became President, secured the dispatch of the expedition of Lewis and Clark.

When young Matthew was in his fifth year the family removed to Tennessee, near Franklin, where they lived the life of early settlers in a new country. His first ambition to become a mathematician was excited by an old cobbler "who used to send the shoes home to his customers with the soles all scratched over with little x's and y's." A fall from a tree in his twelfth year, by which his back was injured, for a time at least seriously, seems to have marked the turning-point of his life. His father, thinking him permanently disabled, yielding to his wish, sent him to Harpeth Academy, of which the Rev. J. H. Otey, afterward Protestant

Episcopal Bishop of Tennessee, and William C. Hasbrouck, were the teachers.

In 1825 he obtained, through the Hon. Sam Houston, a midshipman's warrant in the United States Navy. His father, not approving the career to which this pointed, while not forbidding, refused to countenance him in accepting it. Having thirty dollars which he had earned by doing tutor's work in the academy, young Maury went on his own account for the East. There was no naval academy then, and he went on shipboard at once. He soon showed that his mind was set upon mastering the theory and practice of his profession. "It is related by some of his companions of that period," says Mrs. Corbin, "how he would chalk diagrams in spherical trigonometry on the round-shot in the quarter-deck racks, to enable himself to master problems, while pacing to and fro, passing and repassing the shot-racks on his watch." With an old Spanish work on navigation, he pursued the double object of studying the Spanish language and adding to his stock of nautical information. His first voyage was to England, in the Brandywine, which conveyed General Lafayette home to France; his next was in the Vincennes, round the world. On this voyage he constructed a set of lunar tables and prepared himself for examination.

During his next cruise of four years on the Falmouth, Dolphin, and Potomac, beginning in 1831, Maury conceived the idea of his current and wind charts; observed and began to study the curious phenomenon of the low barometer off Cape Horn, concerning which he wrote his first scientific paper—for the American Journal of Science; and began to prepare for the press a work on navigation, for which he had been several years collecting the material. It was published in 1839, was favorably noticed in England, and was used as a text-book in the United States Navy.

Maury next received an appointment as astronomer and hydrographer on the South Sea Exploring Expedition, which was to go out under Commodore Catesby Jones, and, preparatory to it, practiced in the use of the telescope, transit instrument, and theodolite; but, Captain Wilkes succeeding to the command, he resigned, in order to permit the new commander to select his own associates. He was then assigned the duty of making surveys of Southern harbors. While traveling on leave of absence from this work, his leg was broken by the overturning of a stage-coach, whereby he was disabled from active service for several years. The misfortune is regarded by his biographer as having been a "blessing in disguise"; for it caused his mind to turn more intently to the scientific side of his work, and thus contributed indirectly to the fruitfulness of thought by which his after-life was distinguished.

A series of articles on naval reform and kindred subjects, entitled Scraps from the Lucky-Bag, published by Maury under

the pen-name of Harry Bluff, attracted attention and approval. Among the points discussed in them—most of which were brought up for the first time—were the adoption of steam as a motive power; great-circle sailing; the establishment of navy-yards and forts at Memphis and Pensacola; the use of blank charts on board public cruisers; the Gulf Stream and its causes; the connection of terrestrial magnetism with the circulation of the atmosphere; and a ship-canal from the Illinois River to Lake Michigan. The papers gave their author fame, and secured respect for his opinions on naval questions. He was placed in charge of the Depot of Charts and Instruments at Washington, an office which was developed into the Naval Observatory and Hydrographical Department. "No man," said Senator John Bell, "could have been found in the country better fitted than Maury for this difficult duty; and he worked with the zeal and energy that were expected of him."

One of Maury's first enterprises in this office was the compilation of his wind and current charts and sailing directions. He had already, as sailing-master of the Falmouth, in 1831, observed the want of trustworthy information concerning the winds and currents encountered by mariners. He then resolved, if he ever had opportunity, to compile such information from the store of old log-books in the Hydrographical Bureau of the Naval Department. This he now did, and his charts and sailing directions were furnished to the masters of vessels bound for foreign ports, who in turn supplied the results of their own observations. The most favorable reports came in of the value of the work, and it was illustrated by some then really wonderful incidents.

The fact was demonstrated in American and English journals that, by the mere shortening of voyages they made possible, these charts effected a very great saving in the expense of commerce between distant ports. Testimony was repeatedly borne to their value in the annual reports of the Navy Department and of congressional committees. Secretary Dobbin reported, in 1855, that other maritime nations, appreciating the value of this plan of investigation, had united in a common system of observations for its further prosecution; and that it was suggested by Lieutenant Maury that the same system of meteorological research, "if extended to the land, would afford for the agricultural interests of the country, and for science too, results quite as important as those which commerce and navigation have already received from it." While analyzing and tabulating these "millions of observations," Maury wrote his Physical Geography of the Sea, which took rank at once as a masterly as well as a charming work. In the preface to it the author attributed such success as he had achieved to the observance of the rule "to keep the mind unbiased by theories and speculations; never to have any wish that

an investigation should result in favor of this view in preference to that; and never to attempt by premature speculation to anticipate the results of investigations, but always to trust to the investigations themselves." The book met a large demand at home and abroad, more than twenty editions having been sold in England alone; and it was translated into the French, Dutch, Italian, Swedish, and Spanish languages. Following this came the assembling of the Meteorological Congress at Brussels, in 1853, of the chief nations interested in commerce, at which a uniform system of observations on land and at sea was resolved upon. Among the incidents of the conference was a letter in 1857 from Humboldt, "at the age of ninety years," relating to its results, and offering "to my illustrious friend and associate . . . the tribute of my respectful admiration. . . . It belongs to me, more than to any traveler of the age, to congratulate my illustrious friend upon the course which he has so gloriously opened."

Lieutenant Maury, after returning from the Brussels Conference, pressed the scheme of co-operation in meteorological observations on land. In addresses delivered at agricultural societies in 1855 he urged farmers to make daily observations of weather conditions and the state and yield of the crops, to be sent to him, as sailors were sending their observations at sea; and he advised them to seek from Congress measures for the establishment of a central office where these reports could be digested and the results sent monthly, weekly, or even daily, to all parts of the country, so that farmers could be "warned of the approach of storms, severe frosts, etc., that might prove injurious to the crops." He defined this proposition in an address before the United States Agricultural Society in January, 1856, as a concerted plan, the idea of which was to spread the network of instruments and observers in this country and over other parts of the world also, to which he was assured the co-operation of men of science abroad would be given. About three years afterward, in an address at Decatur, Ala., as if foreseeing that his services might become forgotten, he said: "Take notice, now, that this plan of crop and weather reports is my thunder; and if you see some one in Washington running away with it, then recollect, if you please, where the lightning came from." The whole record of Maury's meteorological work, and his part in advocating this plan, were reviewed by Senator Harlan, in a committee report to the United States Senate, made in 1857. His scheme also embraced a system of meteorological observations on the Great Lakes. Records had already been kept for many years by the army, to which, Maury acknowledged, "alone we are indebted for almost all we know concerning the climatology of the country"; but he explained that their value was retrospective; while the observations he proposed were to

be used for predictions and warnings of what the weather was to be.

As early as 1848 Maury had concluded, from his investigations of the winds and currents, that a broad and level plateau—the "telegraphic plateau"—existed at the bottom of the ocean between Newfoundland and Ireland. His view was confirmed by the deep-sea soundings that were taken at his instance between 1849 and 1853; and early in 1854 he reported to the Secretary of the Navy that, so far as the bottom of the deep sea was concerned, a submarine telegraph between Newfoundland and Ireland was practicable. A plateau seemed to have been placed there especially for holding the wires and keeping them out of harm's way. His views respecting the manner of constructing cables were confirmed, both in the behavior of the first cable, constructed differently from them, which failed, and the others, made more in harmony with them, which were successful. At the dinner given in celebration of the arrival of the first message across the Atlantic, Mr. Cyrus W. Field said, referring to the enterprise, "Maury furnished the brains, England gave the money, and I did the work."

A painful surprise came to Lieutenant Maury when the Naval Retiring Board, under the act of Congress of February 28, 1855, placed him on the retired list on leave-of-absence pay, but without detaching him from the Naval Observatory. He regarded the act as an indignity. He wrote to three of the Secretaries of the Navy under whom he had served for expressions concerning his efficiency, particularly inquiring why he had been kept at the observatory instead of being sent to sea. Ex-Secretary Graham answered: "I considered your services at the National Observatory of far more importance and value to the country and the navy than any that could be rendered by an officer of your grade at sea in the time of peace. Indeed, I doubt whether the triumphs of navigation and of the knowledge of the sea achieved under your superintendence of the observatory will not contribute as much to an effective naval service and to the national fame as the brilliant trophies of our arms." Mr. John P. Kennedy wrote, "From my knowledge of the nature of your scientific pursuits, their usefulness to the country, and your devotion to them, I can say that nothing but such an emergency as left me no alternative, would have induced me to withdraw you from your labors at the observatory by an order to go to sea." Mr. William Ballard Preston wrote to similar effect. In the following winter Maury was, by special act of Congress, reinstated and promoted to the rank of commander, with back pay from the date of his retirement.

Other schemes discussed by Lieutenant Maury in general or special papers, included the location of lighthouses on the Florida

and Gulf coasts; systematic observations of the rise and fall of the water in the Mississippi River and its tributaries, with gauges at all the principal towns; the redemption of the "drowned lands" of the Mississippi; navigation by great-circle routes; a ship-canal and railroad across the Isthmus, which he insisted should be by way of Panama or Nicaragua rather than Tehuantepec; the establishment of a great port at Norfolk, Va.; and the colonization of the surplus black and other population of the South in the valley of the Amazon. The Darien expedition of Lieutenant Strain and Lieutenant Herndon's exploration of the Amazon were connected with two of these schemes. The "lane route," followed by some of the transatlantic steamship lines, originated in the publication by Maury, in 1855, of a chart on which two lanes were laid down, each twenty-five miles broad, by following which the danger of collisions might be reduced. In acknowledgment of the value of the service rendered by this plan, and by the wind and current charts and sailing directions, the merchants and underwriters of New York presented him with five thousand dollars in gold and a handsome service of silver.

When the Ordinance of Secession was passed by the Legislature of Virginia, Commander Maury believed that his paramount obligation was to his native State. He accordingly left the service of the United States and identified his fortunes with those of Virginia and the Confederacy. There can be no doubt of his disinterestedness in taking this course. His merits and the value of his services were generally recognized throughout the North, and he had but recently given courses of lectures in the principal towns and cities, which were a series of popular ovations to him. In going into the service of the Confederacy he put himself under the direction, as his immediate superiors, of two men who, as United States Senators, had been prominent in opposition to his reinstatement after he had been put upon the retired list, and who are said to have been hostile to him before the war and through it. Of the manner of his leaving the service of the United States, he said, May 12, 1861, in a letter to a friend in Newburg, N. Y.: "I only saw last night the remarks of the Boston Traveller about Lieutenant Maury's treachery, his desertion, removal of buoys. It's all a lie! I resigned and left the observatory on Saturday the 12th ult. I worked as hard and as faithfully for 'Uncle Sam' up to three o'clock of that day as I ever did, and at three o'clock I turned everything—all the public property and records of the office—regularly over to Lieutenant Whiting, the proper officer in charge. I left in press Nautical Monograph, No. 3, one of the most valuable contributions I ever made to navigation; and, just as I left it, it is now in course of publication there, though I shall

probably not have the privilege of reading the proof. . . . As for the buoys, I touched them not!" The Grand Duke Constantine and Napoleon III offered him positions in Russia and France, respectively, which he declined. He became a member of a Council of Three to assist the Governor of Virginia, and in June, 1861, was appointed Chief of the Sea-coast, Harbor, and River Defenses of the South. He assisted in fitting out the Merrimac; invented a torpedo to be used for harbor and land defense; and was engaged, in the summer of 1862, in mining the James River below all the defenses, when he was ordered to go to Europe to purchase torpedo material. During the first and second years of the war he published a series of papers urging the building of a navy, and of protecting the bays and rivers with small floating batteries. He stayed in England, on Confederate business, till the surrender of Lee, when he dispatched a letter to the United States officer commanding the squadron of the Gulf, declaring that he regarded himself in the relation to the United States substantially of a prisoner of war. He then offered his services to Maximilian in Mexico, and accepted the position of Director of the Imperial Observatory. A plan he had conceived for the formation of a colony of Virginians in Mexico was accepted by Maximilian, and he was appointed Imperial Commissioner for Colonization. The scheme was, however, abandoned as soon as Maury left Mexico to return to England. His course in this matter was not approved by his friends, either in Europe or in America. It is claimed that he performed one great service for Mexico during his short career there, in introducing the cultivation of the cinchona-tree.

Returning to England in March, 1866, Maury was given a testimonial, by naval and scientific men, in recognition of his scientific worth and service. He was employed in Paris, by Napoleon III, to instruct a board of French officers in his system of defensive sea-mining. Returning to London, he opened a school of instruction in electric torpedoes, which was attended—at the expense of their governments—by officers of the Swedish, Dutch, and other nations. At the instance of Mr. C. B. Richardson, a New York publisher, he undertook a series of geographical text-books, saying as he went to his task, "I could not wind up my career more usefully (and usefulness is both honor and glory) than by helping to shape the character and mold the destinies of the rising generation." He also wrote a popular book on astronomy, which has never been published.

In 1868 Maury received the degree of LL. D. from the University of Cambridge, along with Alfred Tennyson, Max Müller, and Mr. Wright, the Egyptologist, and declined an invitation from Napoleon III to the directorship of the Imperial Observatory of France. Taking advantage of the general amnesty act to

return to the United States, he declined the offer of the superintendency of the University of the South at Suwanee, Tenn., to accept the professorship of Meteorology at the Virginia Military Institute. Pending his entrance upon the duties of this position, he considered a scheme for establishing a line of steamers between Norfolk and Flushing in Holland. During the last four years of his life he worked at a meteorological survey of Virginia. He engaged actively again in the advocacy of his old scheme for a Telegraphic Meteorological Bureau, in furtherance of which he repeated an address in Boston and Missouri and several places in the South. A paper on this subject presented to the International Congress, at St. Petersburg, for the Advancement of Geographic Knowledge, etc., was unanimously approved by that body. The exposure incident to travel in fulfilling his lecturing appointments brought on the illness which ended with his death; but he continued, to within a few days of that event, dictating and revising the last edition of his Physical Geography.

Commander Maury is described by his daughter as having been a stout man, about five feet six inches in height, with fresh, ruddy complexion, curling brown hair, and with every feature of his bright countenance bespeaking intellect, kindliness, and force of character. "His fine blue eyes beamed from under his broad forehead with thought and emotion, while his flexible mouth smiled with the pleasure of imparting to others the ideas which were ever welling up in his active brain. . . . His conversation was enjoyed by all who ever met him; he listened and learned while he conversed, and adapted himself to every capacity. He especially delighted in the company of young people, to whom his playful humor and gentle consideration made him very winning." N. P. Willis, speaking of him to a friend, said that he made him subject to his personal magnetism, and during a trip while they were together, "unconsciously furnished an exquisitely interesting study of character." He was a firm believer in the Christian religion, but did not join the church till 1867, when he was confirmed with his children in the Episcopal Church. His published works, books, pamphlets, and official papers were numerous, and bore reference to the researches which have been described in this sketch, concerning which they stand as original authorities. Orders were conferred upon him by the sovereigns of Russia, Denmark, Portugal, Belgium, and France; gold medals by those of Prussia, Austria, Sweden, Holland, Sardinia, France, and the free city of Bremen; and other honors by the Pope and Maximilian. He was a member of ten foreign and four American scientific and historical societies that are named, and of many other learned bodies of which the records were lost during the war.

CORRESPONDENCE.

VITIATED MORAL TEACHING.

Editor Popular Science Monthly:

SIR: The letter of E. P. Meredith, in the April Monthly, reviewing the article by Benjamin Reese on "Public Schools as affecting Crime and Vice" in your January number, does not seem to go to the root of the evils deprecated. It is true that high mental culture is not always accompanied by a correspondingly high ethical standard, but often the reverse, and that, as a general rule, our public-school teachers "bear an exceptionally good moral character, and a majority of them are members of good standing in the various churches," and that "the Sunday school, where moral training is especially attended to, is now considered an indispensable adjunct of every church; yet, with all this, vice and crime are on the ascending scale, and in a most astonishing degree." But when he says that "with this guarantee for the moral training of the pupils by precept and example on the part of the teachers, it seems to me that all is being done in that line that can be done," is he equally right? Is there not some moral taint, some poison-bearing germ from which such evils grow, lurking within these ethical influences? When we read of some great bank defalcation, of some much-trusted man absconding with fiduciary funds, and the like, in nine cases in ten the paragraph will end by stating that the perpetrator was a leader in a Sunday school, or a leading man in a church or a mission. Naturally we often ask why it is so. The usual and the easy answer is, that he put on the cloak of religion to screen and facilitate his dishonest methods—"the livery of heaven to serve the devil in." But that facile answer prompts another still more pertinent question, "Why did this professed religious man add hypocrisy to his other iniquities?" Must we not search the foundations of his ethical culture for the fruitful germ from which these evil actions sprang? It is more than probable that had any one of those leaders of a church or Sunday school, or of that majority of public-school teachers "of good standing in the various churches," confessed that he did not believe, or even that he doubted, that the world was made in six days some six thousand years ago; the first man molded from its clay, and the first woman from his newly made rib; that Moses conversed face to face with God; that Lot's wife was turned into a pillar of salt; that infants dying unbaptized are eternally damned; that the laws of nature were set aside when Christ was begot—he would have lost the position he held, and his social standing, as Dr. Robertson Smith, Dr. Woodrow, and many others have, for telling the truth. He was therefore reticent, and soothed his stultified conscience by saying to himself that, if those things were not literally true, they were in a figurative sense, and went on acting if not uttering a lie, as a very large class of people are doing every day for the same reasons. The teacher, preacher, or layman who does this is committing an immoral act, and preparing his conscience for tolerating others of a darker hue. We all know that it is the first willful lie or profane oath uttered that shocks the youthful conscience and sears it for repetitions that cease to shock. The late Henry Ward Beecher told us somewhere that his was so shocked at the first lie, that he sought the attic and behaved in such a peculiar, repentant manner that his mother questioned him, thinking that he was about to experience religion. Now the number of men and women who believe in the supernatural part of our religion is constantly growing less, yet for the reasons that I have alluded to they do not avow it. May it not be this constant acting of a lie that corrodes the conscience and causes, in a measure, the rapidly ascending degree of vice and crime, and the "venality and corruption pervading every branch of the Government"? Have we not reached that stage of enlightenment and that sound policy at which we can safely drop the supernatural from our religion, and relegate it to the cults of less advanced peoples, who still find it necessary to keep that element ingrafted into their theogonies, in order to awe their simple and unintelligent followers? We have outgrown the age of witchcraft which our Puritan ancestors believed in so fully, and we have denied the divine rights of kings, which had the same ethnic origin and for the same ends. Why not eliminate the same element in our religion, retaining all its sound ethical tenets, and administer it upon the human teachings of Christ and the natural laws that science has revealed in the progress of civilization? The time is rapidly approaching when the Bible will be expurgated, and all that science proves false expunged; the stripe-culture of its patristic writers and the foul genesis of Ammonite, Moabite, and Ishmaelite banished to the pages of a dead language, leaving a work that men can read without repulse, and the children in our public schools without pollution. As Mr. Meredith says, "Purify the fountain, and the stream will become likewise limpid and pure."

ADDISON CHILD.

CHILDWOLD, N. Y., *April* 8, 1890.

WHERE FLAX IS GROWN AND MANUFACTURED.

From *The Irish Textile Journal.*

UNDER this heading a correspondent in Boston sends us for verification the following cutting from a magazine article of recent date:

"The finest flax grown in the north of Ireland, in order to attain its highest quality, must be sent to Belgium to be steeped in the water of a certain river. Returning from there, it is spun into superfine yarns by the best machinery and in the naturally adapted moist climate of Belfast. At that stage the product is again sent back to Belgium, where it is woven into gossamer-like fabrics, in low, damp cellars, under conditions that would not be agreeable to the north of Ireland, and the work of the Belgian hand-loom weaver must then be carried back to be bleached under the dripping skies of the Green Isle."

The writer of the foregoing is a little mixed in his ideas. The finest flax comes to us from the Courtrai district, and the "certain river" in which it is steeped is the Lys, but no flax is sent from Ireland to be steeped there. Courtrai flax is used by our spinners for the finer counts of their yarns, chiefly for hand-loom linens; but these goods are not necessarily woven in low, damp cellars on the Continent any more than in the north of Ireland, where the finest goods can be made. Some descriptions of "gossamer-like" lace are made in damp cellars in France, and from hand-spun flax of the very finest quality, worth £180 to £200 per ton. Of course, we claim for Ireland that it possesses the best climate in the world for bleaching, but only a small quantity of foreign linen is sent here to be finished.

Editor Popular Science Monthly:

SIR: In reply to your esteemed favor of the 10th, received this morning, I have to say that while the object of the remarks quoted from the Irish Textile Journal apparently is to discredit or belittle the statements in the extract given from The Popular Science Monthly, it is the fact that these statements are only confirmed thereby in quite a remarkable manner. While, for instance, there may appear to be a contradiction in the point made by the Irish authority when he says that "no flax is sent from Ireland to be steeped" in Belgium—that is, at the present time—an examination of the text of The Popular Science Monthly will show that no statement on that subject is contained therein, and that it was not necessary to the argument. If the critic in question had been able to say that no Irish flax *had ever been* sent to Belgium for the specified purpose, or that no benefit would have been derived therefrom, then his remarks would have possessed a measure of weight and of justification that the mere fact of its being apparently for the moment, for undefined reasons, more advantageous to employ Belgian-grown flax does not confer upon them. The other comments made by the same journal require absolutely no reply, when it is borne in mind that the statements of The Popular Science Monthly article have reference only to the accomplishment of the highest possible excellence in a certain limited industry at a given period, and by no means can be held to apply to the production of Irish fine linen generally or permanently, or to other similar fabrics that may be produced in different parts of the world.

Yours very truly,

J. J. MENZIES.

220 SOUTH HILL STREET, LOS ANGELES, CAL., *April* 17, 1890.

A CENSUS OF HALLUCINATIONS.

Editor Popular Science Monthly:

SIR: May I ask for the publicity of your pages to aid me in procuring co-operation in a scientific investigation for which I am responsible? I refer to the Census of Hallucinations, which was begun several years ago by the Society for Psychical Research, and of which the International Congress of Experimental Psychology at Paris, last summer, assumed the future responsibility, naming a committee in each country to carry on the work.

The object of the inquiry is twofold: (1) To get a mass of facts about hallucinations which may serve as a basis for a scientific study of these phenomena; and (2) to ascertain approximately the *proportion of persons* who have had such experiences. Until the average frequency of hallucinations in the community is known, it can never be decided whether the so-called "veridical" hallucinations (visions or other "warnings" of the death, etc., of people at a distance), which are so frequently reported, are accidental coincidences or something more.

Some eight thousand or more persons in England, France, and the United States have already returned answers to the question which heads the census sheets, and which runs as follows:

"*Have you ever, when completely awake, had a vivid impression of seeing or being touched by a living being or inanimate object, or of hearing a voice; which impression, so far as you could discover, was not due to any external physical cause?*"

The Congress hopes that at its next meeting, in England in 1892, as many as fifty thousand answers may have been collected. It is obvious that, for the purely statistical inquiry, *the answer "No" is as important as the answer "Yes."*

I have been appointed to superintend the census in America, and I most earnestly bespeak the co-operation of any among your readers who may be actively interested in

the subject. It is clear that very many volunteer canvassers will be needed to secure success. Each census blank contains instructions to the collector and places for twenty-five names; and special blanks for the "Yes" cases are furnished in addition. I shall be most happy to supply these blanks to any one who will be good enough to make application for them to

Yours truly,

(Professor) William James,
Harvard University, Cambridge, Mass.

THE MYSTERIOUS MUSIC OF PASCAGOULA.

Editor Popular Science Monthly:

Sir: Mr. Chidsey's article upon The Mysterious Music of Pascagoula, in your April number, recalls a recent experience of mine. While cruising on the west coast of Florida, we lay at anchor one night at Rocky Point in Old Tampa Bay, and heard most distinctly a very curious musical note of some denizen of the water. The sound consisted of a single note, and was continuous for a long time. It recalled the singing of telegraph wires, or the hum of a planing-mill, or the music of an Æolian harp. It occasionally approached or receded, and more than one such note—apparently from different animals—could at times be heard at once. In our cabin the sound seemed very distinct, but it was in reality probably faint, as it was hardly, or not at all, audible upon deck. My companion and myself have both cruised along the Gulf coast south of that point before, but had never heard this sound anywhere else; our captain, also, had never heard it anywhere else, but said it was always to be heard at Rocky Point, which is a principal oystering-ground for Tampa. The sound bore no resemblance to that of the drum, which is very common in Florida, and which is a booming, interrupted noise. Its most remarkable peculiarity was its steady continuance—it certainly often lasted without interruption for several minutes.

Yours, etc., William M. Meigs.

216 South Third Street,
Philadelphia, *April* 16, 1890.

EDITOR'S TABLE.

A MORAL ISSUE.

To many of our friends, as we learn from letters that reach us from time to time, the position that The Popular Science Monthly takes up on political and economical questions appears more or less "one-sided." They would wish us, if we can not throw our influence on the side of paternal and protective government, at least to hold the scales even between that system and the anti-paternal, anti-protective system, to which manifestly our preference is given. We are sorry to disappoint any who find our pages sufficiently interesting to command their attention, but we do not see that we can abandon our present attitude. There is enough of trimming, enough of compromise, enough of the non-committal style of writing in the newspaper press: a magazine that professes to represent science may be pardoned for being true to what it conceives to be the teachings of science. What we are compelled to see in the restrictions that governments impose upon the course of trade is not a true statesmanship or a generous public policy, but simply a series of transactions, or, as they are now more familiarly called, "deals" with different private interests. Who can truthfully deny that this is the case? Certain manufacturers ask for protection and get it. What is their object in asking? Surely their own private gain. What do they ask? That other people may be forced to buy their goods, so long as the price is kept within a certain figure which is fixed far above the value of such goods in the markets of the world. Is this a righteous demand to make? It seems to us far from righteous. It seems to us that a man who approaches the Legislature with a request that the power may be conferred upon him by law to force his goods at a high price upon people who could buy, and would much prefer to buy, other goods at a lower price, comes forward with an essentially immoral proposition. But what if the people at large accept the proposition, it may be asked. What if they are willing to impose a heavy tax upon them-

selves in order that certain manufactures may be established in the country? We answer, that if the people were really willing to impose the tax upon themselves, there would be no need of the law. It is just because if the cheaper goods were accessible, everybody would buy them, that the applicant for "protection" seeks to tie the hands of the public. But we are not without positive information as to the relation of protection to politics. We know that in the highest political circles men who have had the tariff fixed to suit themselves are regarded as having received important personal favors. They have been put in the way of accumulating large stores of "fat" at the expense of the public, and if they are not forward in yielding up a little of the fat, when required, to help the party that framed the tariff so accommodatingly, indignant chairmen or secretaries of committees are apt to talk in a very menacing way about "frying the fat out of them."

The issue we see here is a moral one. Certain relations between the state and individuals are moral, natural, right. Certain other relations are abnormal, unnatural, wrong. Certain relations give rise to no evil; others are inseparable from evil. The protectionist *régime* is fruitful—can any candid man deny it?—in hypocrisy and fraud: hypocrisy on the part of those who, while solely intent on their own gain, make the most specious pretenses of patriotism and philanthropy; and fraud on the part of those who are led into attempts to evade a portion of the huge tax levied on the goods they import. The *régime* of non-interference would, in these two respects, lift a tremendous burden off the morals of the community. Who can pretend, in the face of known facts, that the relations between the seekers after protection and the tariff-makers are of a moral kind? How is it possible that we should have honest legislation, when interest after interest is constantly appealing for assistance or the continuance or increase of assistance, pledging itself tacitly if not expressly to return the favor when election-day comes round?

A well-known French economist, M. Courcelle-Seneuil, has lately expressed himself so vigorously and pointedly on this subject in the columns of the Nouvelle Revue, that we are tempted to quote one or two of his observations. Speaking of the common opinion that it is the business of government to promote the wealth of the community by special legislation, he says: "All inquiry in regard to this matter demonstrates: (1) That governments in general have no competence in questions of trade and industry of a nature to authorize them to regulate and control these departments of activity; (2) that the best means of enriching a nation is to leave its industry and commerce absolutely free; (3) that in interfering in commerce and industry the governing power can only transfer to one citizen the wealth of another, contrary to the very end of its institution, which is to maintain peace by justice. Justice consists in defending individual citizens against the violence or fraud which their fellows might otherwise exercise against them, while leaving to each as far as possible the conditions of existence natural to him as an inhabitant of the planet. The government could only favor a certain number by giving them what it had taken from the rest; in other words, by practicing the very thing which its business is to prevent—namely, injustice. . . . For example: I am carrying on an industry; I affirm that the nation has an interest in having that industry favored or 'protected,' as they say; I add that, if it is not protected, either by means of a bounty paid out of the public chest, or by a tariff that shall enable me to levy a tax upon consumers for my own benefit, I can not continue my business. One or other of the two affirmations may be false, and both commonly are. Nevertheless, the public are so accus-

tomed to be imposed upon by words, that both affirmations may be admitted without verification, particularly if they are maintained by persons of great wealth who go about in their carriages begging alms of other people. . . . Established for a quite different purpose, the government has no competence in industrial matters, and can only act therein upon the advice of others. *This advice is nearly always interested and unjust.*"

How entirely we concur in these remarks has already been indicated. If any one can show us that we are wrong in viewing this whole question in a moral light, and pronouncing for that theory of government which seems to us most favorable to public and private morality, we shall be prepared to consider it in other aspects, and listen with patience to the argumentations of those who would fain persuade us that restrictions on the activity and free initiative of individual citizens make for the strength and prosperity of the people as a whole, and that the national wealth is increased when goods are produced in the country at relatively high cost, which might be procured from abroad at relatively low cost.

The above remarks apply to tariff legislation, but individual liberty is abridged in many other ways that seem to us essentially wrong. That the members of a particular profession should have laws passed in their special interest, and should be empowered to decide who may and who may not enter into competition with them, is, we think, a violation at once of justice and of liberty. The worst of these things is, that a public motive is always alleged for what is in the main, if not exclusively, the outcome of private greed or jealousy. It would scarcely be too much to say that the most offensive forms of trade-unionism are found in connection with the so-called learned professions. Time was when it was supposed that the state had to look after the spiritual health of individuals; and for that purpose to prescribe their theological beliefs and religious observances. That belief has for the most part been exploded in the modern world, but its place has been taken by the notion that the state is responsible for the intellectual health of its members; and in lieu of the state church we have state schools. As regards the physical health of the community, the general method is to legalize one or two—possibly quite conflicting—schools of medicine, and to empower them to rule out, and if necessary to prosecute and punish, all others. Nobody, broadly speaking, seems to believe that, in the absence of all legislation of this character, people could in any adequate manner preserve their health or protect themselves against gross imposture. *We* believe it—believe it most heartily; and we believe that the science of medicine would advance far more rapidly, and that, on the whole, the public health would be far better, if every man were left perfectly free to employ any one he chose to attend him in sickness. At present every licensed practitioner feels himself authorized to call every unlicensed practitioner a quack. We should prefer a system under which, to a quickened public intelligence in questions of health and disease, the quack should stand revealed by his quackery. How much of real quackery is now concealed by the license to practice it might distress a confiding public to know.

Our voice may be as that of one crying in the wilderness, but we cry with conviction when we call for more individual liberty, with its correlative individual responsibility. There is something wrong, something vicious, in the application of compulsion where freedom of choice is indicated by all the natural conditions of the case. Force should be reserved for cases in which force is required, where nothing else will serve the purpose, and where the purpose is vital to the life of the society. In other cases the application of force is wrong. The issue of "Man *vs.* the

State" is a moral issue; and the more the question is looked at in that light, the more irrelevant, or at least unnecessary, other lines of argument will appear.

LITERARY NOTICES.

HYGIENE OF CHILDHOOD. By FRANCIS H. RANKIN, M. D. New York: D. Appleton & Co. Pp. 140. Price, 75 cents.

IN this little volume plain and practical advice is given in regard to taking care of the health of children, from about two and a half years of age to the completion of puberty. Among the subjects here treated which are liable to be carelessly regarded by parents are sleep, regularity of the bowels, care of the skin, and school hygiene. The author introduces also some observations on proper discipline—an essential in securing the child's obedience to the laws of health. The important subjects of food and clothing receive full consideration. Until very recently, as the author states, nearly half the mortality in our larger cities was of children under five years of age. When this is contrasted with the few deaths of children among people living in a state of nature, the wholesale manner in which civilized parents slaughter their offspring through ignorance and carelessness becomes evident. When Catlin went among the Indians he found that deaths of children under ten years of age were very rare: in one of the smaller tribes there had been only three in ten years; in the cemetery of another, where the bodies were placed above-ground on scaffolds, Catlin found only eleven bodies of children in one hundred and fifty. With the improvement of sanitary conditions in cities the death-rate of the children has decreased, and there is no doubt that with the spread of such knowledge as Dr. Rankin gives will come a still better showing.

ESSAYS OF AN AMERICANIST. By DANIEL G. BRINTON, A. M., M. D. Philadelphia: Porter & Coates. Pp. 489. Price, $3.

IN this volume Dr. Brinton has collected a considerable number of his essays and addresses read on various occasions, and published in the proceedings of the societies to which they were presented. These he has revised, and in many cases extended; and to them he has added several papers never before published. The special purpose which he designs the volume to serve is stated in the following words from his preface: "In a number of points, as for example in the antiquity of man upon this continent, in the specific distinction of an American race, in the generic similarity of its languages, in recognizing its mythology as often abstract and symbolic, in the phonetic character of some of its graphic methods, in believing that its tribes possessed considerable poetic feeling, in maintaining the absolute autochthony of their culture—in these and in many other points referred to in the following pages, I am at variance with most modern anthropologists; and these essays are to show, more fully and connectedly than could their separate publication, what are my grounds for such opinions." Dr. Brinton classifies these essays under four heads: ethnologic and archæologic, mythology and folk-lore, graphic systems and literature, linguistic. Their general range is indicated by the following titles, which are only a small part of the whole: A Review of the Data for the Study of the Prehistoric Chronology of America; On Palæoliths, American and other; The Sacred Names in Quiche Mythology; The Writing and Records of the Ancient Mayas; Native American Poetry; Some Characteristics of American Languages; and The Curious Hoax of the Taensa Language. In the essays on graphic systems a number of hieroglyphs are figured.

A DICTIONARY OF APPLIED CHEMISTRY. By Prof. T. E. THORPE, Ph. D., assisted by Eminent Contributors. In Three Volumes. Vol. I. London and New York: Longmans, Green & Co. Price, $15.

THE subject-matter of this work is pretty closely restricted to chemical technology and medicinal chemistry, space being allowed for purely scientific aspects of the science only when they have some direct bearing upon an art or manufacture. For all such matters the student is referred to the new edition of Watts's Dictionary of Chemistry, to which the present work may be regarded as complementary. In preparing the articles special attention has been paid to the bibliography of the subjects, and, in certain cases, to the

compilation of trustworthy patent-lists. Volume I goes from A to Dy. Among its chief articles are those on acetic acid, alcohol, alizarin and allied coloring matters, aluminium, ammonia, analysis, azo-coloring matters, bleaching, brewing, carbon, cements, chlorine, cyanides, dextrose, disinfectants, and dyeing. Under alizarin are given the history of the artificial production of this substance, the methods of preparing a large number of derivatives of anthraquinone, and accounts of the anthraquinone and dichloranthracene processes of manufacturing alizarin. The article on brewing comprises quite full consideration of the sources and chemical character of the water, barley, and hops used in making beer, with descriptions of the several steps in the process. Sixteen figures of brewing apparatus are given. In the article on cements, both building cements and adhesive cements are treated. Under the former division are included lime-burning, mortar, plaster of Paris, hydraulic mortar, pozzuolana, hydraulic cement, oxychloride cements, artificial stone, and concrete. Analyses of many of these substances are given in tables, and a bibliography of the subject is appended. Many of the articles involving descriptions of apparatus are fully illustrated. The more important ones are signed, and a list of contributors to the volume is prefixed, among which may be found many well-known names.

GEMS AND PRECIOUS STONES OF NORTH AMERICA. By GEORGE FREDERICK KUNZ. Illustrated with Eight Colored Plates and numerous Minor Engravings. New York: The Scientific Publishing Company. Pp. 336. Large 8vo. Price, $10.

MR. KUNZ has written a very interesting book, and it has been published in an elegant style. Nearly all the known varieties of precious stones occur in North America, and many of the American specimens have much beauty, but they are not found of such size and quality nor in sufficient quantity to rank them as an important product of the country. About one hundred thousand dollars' worth of precious stones, including pearls, are found in the United States yearly, but this is less than the value of the output from the diamond-mines of South Africa, or from our coal and iron mines, for a single day. The occurrence of diamonds in the United States, Mr. Kunz tells us, is chiefly confined to two belts of country: one along the eastern base of the Alleghanies, from Virginia to Georgia; the other along the western base of the Sierra Nevada and Cascade Ranges in Oregon and northern California. The Dewey diamond, found at Manchester, Va., in 1855, weighed before cutting 23¾ carats, and 11$\frac{11}{16}$ carats afterward. It passed through several hands, becoming the property of John A. Morrissey, who had made a loan of six thousand dollars on it. As it is off-color and imperfect, it is to-day worth not more than three or four hundred dollars. Mr. Kunz gives the history of the finding of a number of other American diamonds, many of which were picked up by children, or by persons knowing nothing of mineralogy. Some of these were destroyed by being struck with a hammer, their finders having an idea that this was a test which a diamond ought to stand. He also tells of reported finds of diamonds in which the stone turned out to be a quartz crystal which had been rolled among the gravel of some stream till it had acquired the appearance of a rough diamond.

Pieces of blue glass similarly worn into the shape of pebbles have been taken for sapphires. The largest crystal of sapphire ever found is in the Shepard mineral collection at Amherst College. It weighs three hundred and twelve pounds, is a perfectly terminated prism, partly red and partly blue in color, but opaque. It was obtained by Mr. C. W. Jenks from his mine at Franklin, N. C. In his chapter on the turquoise Mr. Kunz tells of its use by the ancient Mexicans, and by the Indians of the Southwestern United States, and gives pictures of several ornaments of their workmanship. He tells where the ruby, topaz, and emerald are found, and where occur a large number of less valuable stones, such as the garnet, tourmaline, beryl, amethyst, opal, agate, jasper, silicified wood, lapis lazuli, moonstone, sunstone, obsidian, amber, jet, cat's-eye, serpentine, malachite, and very many more whose names are less familiar. His account of Chalcedony Park in Arizona, where there are great blocks and whole tree-trunks turned to agate, is a very interesting portion of the book. There is also a remarkably attractive and fully illustrated chapter on pearls. The chief pearl-fishing grounds

of America are in the Gulf of California, but pearls are also found in shells of the unio, mussel, common clam, and other shell-fish all over the United States. Within one year they have been sent to the New York market from nearly every State in the Union. One worth five hundred dollars was found in Wisconsin in 1889, and others ranging in value up to three hundred dollars have been found in Vermont, Ohio, Texas, and Tennessee. The archæologist will be especially interested in the chapter on aboriginal lapidarian work in North America, and the general reader will obtain much welcome information from the concluding chapter dealing with imports, values, cutting of diamonds and other stones, mineral collections, and uses of precious and ornamental stones for silver articles and furniture and for interior house decoration. Mr. Kunz was eminently well fitted to produce this work, as he is the gem expert for Messrs. Tiffany & Co., has prepared several reports on the precious stones of the United States for the Geological Survey, and is the special agent in charge of this subject for the census of 1890. The magnificent plates showing all the important stones in their natural colors are the work of Messrs. Prang & Co., of Boston. The many other engravings show articles of aboriginal production, forms of crystals, etc. The book is of standard scientific value, giving as it does the mineralogical characters and chemical analyses of the stones treated, and its handsome form makes it worthy a place in the finest library.

FOOD IN HEALTH AND DISEASE. By J. BURNET YEO, M. D., F. R. C. P. Philadelphia: Lea Brothers & Co. Pp. 583.

No one who examines this book can fail to be astonished at the amount of information that is here compressed within the limits of a small volume. Of course, the author has not put all that is known about dietetics between its covers, but he has gone over the ground with remarkable thoroughness. He describes the preparation, cooking, and preserving of food, tells the chemical composition and the special value of each of the common articles of food, the proper food for the individual at each period of life, from infancy to advanced age, tells how large numbers of persons may be fed cheaply and well, as in prisons, camps, and on board ship, and gives dietaries for all the principal diseases. "I have thought it desirable," says Dr. Yeo in his preface, "to enter fully and in detail into the important subjects of army and prison dietaries, school dietaries, and feeding during the critical period of infancy and childhood. In connection with the first of these subjects I have been at pains to present as fully as possible the admirable system of feeding our soldiers at home stations, so ably devised and carried out by Colonel C. J. Burnett—a system which may serve as a model of wholesome, economical, and intelligent feeding." Dr. Yeo gives a warning against the tendency to overfeeding in adults, especially those who habitually make little physical exertion. The habit of drinking milk with the meals is one way in which the proper amount of food may be exceeded inadvertently. In the part of the volume devoted to food in disease, besides general directions applicable to different diseases, there are given various "cures" known by the names of their originators. An appendix contains tables of hospital dietaries, and another contains a list of select recipes for invalids' dietary.

A NEW MEDICAL DICTIONARY. By GEORGE M. GOULD, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 519. Price, $3.25.

THE aim and scope of this work can be best told by quoting from the preface. The author's purpose has been "to include those new words and phrases created during the past ten years—a period rich in coinages—which appeared destined to continuous usage. . . . To frame all definitions by the direct aid of new, standard, and authoritative textbooks, instead of making a patchwork of mechanical copying from older vocabularies. While neglecting nothing of positive value, to omit obsolete words and those not pertinent to medicine except in a remote or factitious sense. To make a volume that will answer the needs of the medical student and busy practitioner, not only by its compactness of arrangement and conciseness of definitions, but also by its convenience of size and price." A notable feature of the work is its many tables, which comprise abbreviations, affixes, arteries, bacilli, ganglia, leucomaïnes, micrococci, muscles, nerves, plex-

uses, ptomaïnes, comparison of thermometers, weights and measures, mineral springs of the United States, and vital statistics. The article on mineral springs is by Judson Daland, M. D., and forms an appendix of thirty-two pages. At first sight the volume does not make a favorable impression, for its exterior is severely plain, and it appears to be printed from too small type; but very little examination is needed to show that the publishers' claims as to good paper, clear print, and binding so that the book will lie open at any page, are well founded.

HANDBOOK OF GEOLOGY, FOR THE USE OF CANADIAN STUDENTS. By Sir J. WILLIAM DAWSON, C. M. G., LL. D., F. R. S., Principal of McGill University. Montreal: Dawson Brothers. 1889. Pp. 250.

THIS is a practical treatise on geology, well fitted to the needs of those for whom it was written, more than half the volume being devoted to a review of the topography and geology of Canadian territory. It includes the results of the later geological surveys, the observations of Dr. G. M. Dawson in Manitoba and British Columbia in 1886–'87, and also the discoveries in paleontology which have changed the chronology of the *Blattidæ* and other species.

The work is divided into three parts. The first division treats of the constitution of rocks, their classification, the fossils found in them, and their arrangement. In classifying rocks, the distinction made between their origin, chemical nature, and texture is helpful. The second part relates to chronology. The nomenclature adopted by the International Congress is given, and the equivalent terms in use by geologists. The illustrations of the various eras, their fossil plants and animals, are well chosen and complete. The third and longest section is descriptive of the physical and geological features of the country. This is divided into six regions, and examination is made of each. The author does not give much space to the discussion of subjective theories, such as the origin of the metamorphism of rocks, the plasticity of the earth, and other mooted points; but refers to authors who have treated these subjects at length. Even in regard to the deposit of drift upon the plains by icebergs, he points out "difficulties in the way of the theory of glaciation caused by the absence of marine mollusca and other forms of marine life." As the area considered exceeds that of the United States, and representatives of nearly every period from Eozoic to modern times are found within its limits, it is evident that the student who becomes familiar with this rock-structure and history goes forth well equipped as a geologist. Directions are given for slicing rocks and fossils for the microscope, and a description of the tools necessary for the field geologist, with suggestions as to the best manner in which he may pursue his work.

A HISTORY OF MODERN EUROPE. By C. A. FYFFE, M. A. Vol. III, from 1848 to 1878. New York: Henry Holt & Co. Pp. 572. Price, $2.50.

IT is an important period which is covered by Mr. Fyffe's third volume, for during these thirty years many events took place whose influence in European history will be great and lasting. Among these are the creation of the Italian kingdom, the winning of the leading position among the German states by Prussia, and the war between France and Germany in 1870–'71. This period covers the greater part of Bismarck's active career, and includes the years in which Cavour and Disraeli made their fame. Soon after it began, occurred the Crimean War; the dismemberment of Poland was among its events, and it closes with the war between Russia and Turkey. The work is a record of wars and state-craft, and does not attempt to chronicle the progress of social, commercial, and industrial affairs. The book has large, clear print, topics are indicated by marginal titles, and there is a copious index.

THE WAY OUT OF AGNOSTICISM. By FRANCIS E. ABBOT, Ph. D. Boston: Little, Brown & Co. Pp. 75. Price, $1.

THIS little book is no more than a compact introduction to a treatise on scientific religion which Dr. Abbot is preparing. Agnosticism, he says, declares that the scientific method applies only to phenomena, to the appearances or shows of things, and has no possible application to noumena, or things as they really exist in their internal relations and constitutions. A scientific theology, Dr. Abbot maintains, will show that

the scientific method applies both to phenomena and noumena—both to things as they seem and things as they are. Agnosticism, destitute of the conception that God is immanent in nature, does not see that to know nature in any degree is to know God in precisely that degree. There is no unknowable, but simply the unknown or the imperfectly known. Against the relativity of knowledge as held by Herbert Spencer, he affirms that knowledge is based upon the internal self-relatedness of an object. This self-relatedness in its unity and constancy, as Kant observed, is the reason why all who judge an object come to agreement. Formulating the three types of real beings as machine, organism, and person, Dr. Abbot finds the universe to be all three. In the perfect intelligibility of the universe he places his hope for new light on the problems of immortality and duty, which shall be as certain and trustworthy as the light science has already cast on problems of physical nature.

THE ELEMENTS OF LABORATORY WORK. By A. G. EARL, M. A. London and New York: Longmans, Green & Co. Pp. 179. Price, $1.40.

TEXT-BOOKS adapted to the new and genuine method of science study are so few as yet that every progressive educator will welcome this addition to their number. The course which it embodies is designed as an introduction to all branches of natural science, its object being to teach a method of study rather than to convey information in a prescribed field. It is adapted to students in colleges and high-schools. To give an idea of the method of the book we quote the directions for the first exercise:

"*To find equal quantities of matter:* 1. Use a balance, and counterpoise two pieces of wood, cutting away one or the other with a knife until exact balance is obtained. 2. Counterpoise a piece of wood and a piece of lead. 3. Counterpoise another piece of wood with the lead, and then observe that the two pieces of wood counterpoised by the lead counterpoise one another.

"The above exercises show: 1. That with the same kind of matter, wood, the pieces which counterpoise each other are the same size, or thereabout; but different kinds of matter which counterpoise each other are not of the same size. 2. That two bodies counterpoise each other if they each counterpoise a third body, for these two bodies have been found to act alike under the same conditions—that is, when placed in the same position, and with all the surroundings the same. Two such pieces of matter are said to be *equal quantities of matter*, however unequal in size or different in appearance they may be."

Other exercises in weighing and some in measuring length and volume follow. While occupied with weighing, the student is directed to take to pieces a balance very carefully, the points in its construction which it is specially instructive for him to notice being stated. Observations of change of position, of changes of temperature, and of certain mutual changes common to all kinds of matter are among the early exercises of the course. A chapter is devoted to "observations of certain mutual changes exhibited by certain kinds of matter," namely, electrical phenomena. Under the head of "observations which lead to the theory that all matter is made up of very small separate particles" are embraced experiments on solution, diffusion, and the pressure of gases. A number of chemical experiments are given in a chapter devoted to "investigation of the composition of various kinds of matter." The final division comprises experiments in optics, designed to lead to the theory of the ether. An appendix gives many practical hints in regard to conducting the work in the laboratory. Lists of additional exercises and questions are inserted at the end of each chapter, and the text is illustrated with many figures of apparatus and diagrams.

Numbers Universalized is the latter or advanced part of the text-book of algebra by Prof. *David M. Sensenig* (Appleton, $1.25). The work is believed by its author to embrace all algebraic subjects usually taught in the preparatory and scientific schools and the colleges of this country. Part Second is divided into five chapters, as follows: one embracing serial functions, including, among other things, the binomial theorem, and exponential and logarithmic series; one treating of complex numbers, graphically and analytically; one embodying a discussion on the theory of functions; one

treating of the theory of equations, and one treating of determinants and probabilities, so far as the author deems these of interest and value to the general student. The volume closes with a supplementary discussion of continued fractions and theory of numbers. The two parts of the book are paged continuously, and may be had bound together.

Although prepared for English readers, the *Notes on American Schools and Training Colleges*, by *J. G. Fitch* (Macmillan, 60 cents), contains much that American teachers can read with profit. These Notes were made during a visit of the author to America in 1888, and were embodied in his annual official report on English Training Colleges, presented to Parliament in 1889. It is always instructive to see ourselves as other fair-minded observers see us, and this picture of our educational methods from a foreign point of view must help Americans to realize what are the peculiarities, the merits and defects, in a system all parts of which seem to us equally natural and admirable. An introduction has been prefixed to the volume telling how education is supported in England. This is a point on which many Americans appear to be ignorant, and a glaring case of such ignorance by a reverend writer in an American magazine is taken by Dr. Fitch as the text for his remarks. A table showing schemes of graded instruction in primary schools in England, New York, Philadelphia, Chicago, Massachusetts, and Ontario is inserted at the end of the volume.

Volume XI of the *Transactions of the Kansas Academy of Science* covers the annual meetings of 1887 and 1888. Most of the papers embody results of scientific researches on the geology, botany, and zoölogy of Kansas. Among these are Horizon of the Dacotah Lignite, by Prof. Robert Hay; On the Newly Discovered Salt Beds in Ellsworth County, by E. H. S. Bailey; Personal Observations upon the Flora of Kansas, by Mrs. A. L. Slosson; Geology of the Leavenworth Prospect Well, by E. Jameson; A List of the Kansas Species of Peronosporaceæ, by W. T. Swingle; and a Meteorological Summary for the Years 1887 and 1888, by Prof. F. H. Snow. There are also some papers on general subjects.

Prof. *Edwin S. Crawley*, of the University of Pennsylvania, has published a textbook entitled *Elements of Plane and Spherical Trigonometry* (Lippincott, $1), covering that part of the subject which is generally given in a college course. The first part of the subject is presented in much detail, with many examples and illustrations; further on the student is thrown more upon his own resources. In the preface, sections are specified which may be omitted without impairing the continuity of the text, if a shorter course is desired. An appendix contains the formulæ which the student will find most useful in subsequent work in mathematics. Answers to a part of the examples are given at the end of the book.

A fifth edition, revised and enlarged, of the little work on *Electric Light Installations and the Management of Accumulators*, by Sir *David Salomons*, Bart., has just been published (Van Nostrand, $1.50). The book is now more than twice as large as when it first appeared, having been extended to 334 pages, and contains 100 illustrations. The rapidity with which four editions have been disposed of, and the fact that the book has been translated into German and French, are practical indorsements of its value. Besides expanding the chapters of the last edition, the author has added two new ones, and many of the cuts are now inserted for the first time.

Prof. *R. H. Ward*, M. D., has published a revised edition of his record-book for botanical laboratory work entitled *Plant Organization* (Ginn & Co., 85 cents). The preface and introduction explain Prof. Ward's scheme of writing descriptions of plants; then follow twenty pages in which the terms commonly used in describing the parts of plants are defined. Here the author gives, in addition to many of the technical terms, simpler words that may be used by pupils whose course of study will be short. The leaves of the book are tied in by a cord, so that as each printed form is filled out it may be removed and handed to the teacher for examination. The forms, besides lines for descriptive words, have spaces for drawings. Blank pages are inserted, to which dried specimens may be attached.

A manual of hygiene entitled *How to preserve Health* has been prepared by *Louis Barkan*, M. D. (Exchange Printing Company,

New York). It contains advice on all the subjects usually comprised in a health manual grouped under two heads—the prevention of disease and the care of the sick. In the latter department are some directions which the layman is probably not expected to use himself, for, in another place, the author says that "so soon as unmistakable signs of disease are perceived, a physician should be called." The readableness of the volume has been increased by putting into it bits of description and accounts of ways and customs in other countries.

Mr. *Horatio Hale* publishes a *Manual of the Oregon Trade Language, or Chinook Jargon* (London: Whittaker, 3*s.*), written to form part of a volume of linguistics, the work of several contributors, which is not yet published. The author's first study of the subject was made in 1841, when, as a member of a United States exploring expedition, he undertook an account of the ethnology of the Oregon region. He found the jargon to comprise about two hundred and fifty words; the number had nearly doubled in 1853, when the dictionary of George Gibbs was published, since which time no material change seems to have been made in the language. In regard to the present volume, Mr. Hale says, in his prefatory note, "Comprising, as will be seen, a complete grammar and dictionary, with specimens of colloquial and narrative phrases, songs, hymns, a sermon, etc., it is intended to afford a manual for the use of travelers and settlers in the region where it is spoken, as well as an opportunity for philologists to study the construction of a genuine international speech now current, with the best results, among populations in various stages of civilization, speaking more than twenty distinct languages, and diffused over a territory nearly half as large as Europe."

A new solution to the problem of an international language is offered by *Augustin Knoflach* in a pamphlet entitled *Sound-English* (New York: Stechert, 25 cents). The author first sets forth the reasons why English is more desirable as an international speech than any artificial language, and asserts that the only obstacle to such use is its absurd, illogical spelling. He then illustrates some of the irregularities of English spelling, and answers the stock objections to any change in a vigorous and interesting style. In the second part of the pamphlet, Mr. Knoflach presents his method of writing English. It is a phonetic system, the deficiencies in our present alphabet being supplied by new letters. Long vowels are printed in heavy or full-face type. Besides giving the exact sound of each word, Sound-English also indicates the accent. Syllables containing long vowels are generally accented, so the full-face type is a mark of accent. Where this rule does not apply, a consonant is printed in full-face to mark the accent. All capitals are discarded; they are not needed at the beginning of sentences, and proper names are distinguished by the context, as in spoken language. One advantage claimed for this system is that type-writers can be easily modified to write it, the heavy letters being made by holding the space-bar and striking the key twice. An appendix in dialogue form answers objections to Sound-English.

A system of metrology designed to supersede the metric as well as the remaining old systems is set forth by the Hon. *Edward Noel*, in a book entitled *Natural Weights and Measures* (London: E. Stanford, 2*s.* 6*d.*). Its linear unit is an ell of about twenty-five inches, which is one ten-thousandth of the semi-diameter of the earth—the measure used by astronomers for expressing the immense celestial distances. The foot would be half an ell and would contain twelve new inches. All other measures and the weights would be derived from the linear unit, as in the metric system. They would be given the names now used for the old weights and measures. The proposed system differs from the metric in preferring duodecimal division in linear and weight measure, and binary division in surface and capacity measure. The author finds much to say in favor of the United Kingdom, the United States, and Russia adopting the "natural" system together, and he says it well. By description and in tables he presents the system from every point of view, and makes out a very able plea in its behalf, both on practical and on sentimental grounds.

Mary Boole, the author of *Logic taught by Love* (A. Mudge & Son, Printers, Boston), says of her own production: "This

book will seem to some a mere medley. Is it a text-book of logic, a pious exhortation, or a treatise on mythology?" The ordinary person will get exactly this impression from a first glance at the book; but he can not help feeling a respect for the author's mind from the fact that she realizes so well the character of her own work. It consists of a number of essays, dealing chiefly with metaphysics, the Hebrew religion, and educational methods. One object of the volume being to combat monotony and specialization in teaching, the chapters are far from being severely methodical in scope or arrangement. The author insists that too little regard is commonly paid to the bearing of different fields of knowledge upon each other. She makes many references to the work of George Boole, and frequently quotes from his Laws of Thought. Another of her authorities is Gratry, author of the Logique.

Æschines against Ctesiphon, edited by Prof. *Rufus B. Richardson* (Ginn), has been added to the College Series of Greek Authors. A life of Æschines is prefixed to the volume, and notes occupy about two thirds of each of the pages on which the text is printed. The book has a Greek index and an index of subjects.

A Report of Explorations in the Alleghany Region, made by Prof. *David Starr Jordan*, has been published by the United States Fish Commission. This examination had two general purposes: first, to ascertain the general character of the streams of the Alleghany region of Virginia, North Carolina, and Tennessee, and of western Indiana; their present stock of food-fishes, and their suitability for the introduction of species not now found there; second, to catalogue the fishes native to each stream, whether food-fishes or not, in order to complete our knowledge of the geographical distribution of each species, and to throw light on the laws which govern geographical distribution. The results of the observations recorded in this paper accord with a previous conviction of the author, that the question of distribution reduces itself to a question of barriers of various sorts. Each species extends its range in every direction, and holds the ground thus taken if it can.

The *Bulletin of the United States Fish Commission for* 1887 consists of reports and correspondence on a wide variety of topics. Among the more extended articles are reports on the fishes observed in Great Egg Harbor Bay, New Jersey, in 1887, and on the investigations by the schooner Grampus on the Southern mackerel-grounds, and a review of the mackerels of America and Europe (with plates). A fully illustrated paper of over one hundred pages, by J. W. Collins, describes the beam-trawl fishery of Great Britain. Among the articles of more popular interest are an account of the American Sardine Industry in 1886, by R. E. Earll and H. M. Smith; and The Aquarium: a Brief Exposition of its Principles and Management (illustrated), by William P. Seal.

An account of *The History of the Niagara River*, by *G. K. Gilbert*, included in the Report for 1889, of the Commissioners of the State Reservation at Niagara, has been reprinted in pamphlet form. It contains the substance of the lecture which the author gave before the American Association for the Advancement of Science, at its Toronto meeting in 1889, and is written in a style which makes it attractive to the generally intelligent person as well as interesting to the geologist. Mr. Gilbert discusses the changes of outlets of the Great Lakes caused by the advance and retreat of the ancient ice-sheet, and shows their bearing on the history of the Niagara River. He then describes the work of the cataract in cutting out its gorge, and concludes with a list of questions which must be considered before any satisfactory estimate of the rate of recession of the falls can be reached. The paper is illustrated with eight plates.

Three monographs by Mr. *Robert Ridgway*, published in the Proceedings of the United States National Museum, comprise a *Review of the Genus Xiphocolaptes of Lesson*, in which the existence of a much greater number of clearly defined forms than have been recognized by leading authorities was made apparent; a *Review of the Genus Sclerurus of Swainson* — in which several forms that had been "lumped together" had to be distinguished; and a *List of Birds* (sixty-six species) *collected on the Island of Santa Lucia, West Indies, Abrolhos Islands, Brazil, and at the Straits of Magellan*, in 1887–'88, by the Fish Commission steamer Albatross.

Among the later publications by the United States National Museum are descriptive *Notes of New Genera and Species* from the Lower Cambrian or Olenellus Zone of North America, by *Charles D. Walcott*; *New North American Acrididæ*, found north of the Mexican Boundary, by *Laurence Bœmer*; description of *Two New Species of Snakes from California*, by *Leonhard Stejneger*; *Report on the Batrachians and Reptiles collected by the United States Fish Commission Steamer Albatross* in 1887–'88, by *E. D. Cope*; *Description of New Species of Fishes collected at the Galapagos Islands* and along the coast of the United States of Columbia during the same expedition, by *D. S. Jordan* and *C. H. Bollman*; and *Annotated Catalogue of Insects, collected by the Albatross in* 1887–'88, by *L. O. Howard*.

Two essays on *Primitive Architecture* have recently been published by *Barr Ferree*. In one, on Sociological Influences, reprinted from The American Naturalist, he tells how the form and arrangement of the dwelling have been modified according as the occupants were a single family or several families living in communism, as they were sedentary or nomadic, timid or warlike, etc. In the other, first published in the American Anthropologist, he takes Climatic Influences for his subject, and shows how they have affected the pitch of roofs, the size of windows, the closeness of walls, the choice of material, etc.

Mr. *Alfred R. Wolff* (New York) has published a pamphlet on *The Ventilation of Buildings*, in which he states the problem that the architect has to solve, correcting several popular misconceptions about ventilation, shows by what calculation the proper quantity of fresh air to be supplied to the inmates of a room may be found, and calls attention to the fact that efficient ventilation in cold weather involves additional expense in heating. He then considers several methods of obtaining the required supply and removal of air, and the relation of the usual methods of heating to ventilation.

The Second Annual Report of the Agricultural Experiment Station of Cornell University (published by the University, Ithaca, N. Y.) contains the reports of the several officers of the station, appended to which are Bulletins 5 to 15 inclusive, dealing with the production of lean meat in mature animals; whether heating milk affects the butter made from it; fodders and feeding-stuffs; influences of certain conditions upon the sprouting of seeds; wind-breaks in their relation to fruit-growing, tomatoes, deterioration of manure, etc. Many of the papers are illustrated.

The Fourth Reading-Book in Lippincott's New Series, by *Eben H. Davis* (Lippincott, 80 cents), is made up of selections in prose and verse from standand English and American authors, including some recent writers, whose works are drawn upon by permission of their publishers. A Chapter of Suggestions for Training the Voice is prefixed, and a list of questions for the use of teachers and a vocabulary are appended. The volume is illustrated.

A collection of *Heroic Ballads*, edited with notes by *D. H. Montgomery*, has just been issued (Ginn, 50 cents). The volume contains sixty-eight ballads, among which are many whose excellence has made them long popular, such as Macaulay's Horatius, Ivry, etc.; Aytoun's Execution of Montrose, and Edinburgh after Flodden; Marco Bozzaris, Casabianca, Lochinvar, Barbara Frietchie, Sheridan's Ride, and Curfew must not ring To-night. Others less familiar are Cowper's Boadicea, Scotland's Maiden Martyr, Shan Van Vocht, Song of Marion's Men, The Song of the Camp, and Lowell's Commemoration Ode. Explanatory notes are introduced at the foot of the pages, and indexes to these notes and to the authors represented are appended to the volume.

A very full treatise on whist, entitled *American Whist Illustrated*, has been written by *G. W. P.*, the author of American Whist and Whist Universal (Houghton, $1.75). He states that this publication is a digest of his two previous volumes, with all the amendments, revisions, and changes in play required by the application of recent inventions and improvements in the practice of the American game. The volume is introduced by a short history of cards, including the game of modern whist; then follow the laws of American whist and the rules of a Boston whist club—the Deschapelles. In his rules for original leads and his analyses of the play of second, third, and fourth hands, the author is liberal with reasons and

explanations. The characteristics of American Leads and of "The New Play" are fully explained and illustrated, and due attention is given to a large number of special topics. A chapter of some sixty pages on Whist Practice consists of rules and counsel designed to stimulate the indifferent player to become a good one. A sample conversation, such as is carried on by four persons of the former sort, is also introduced. Twenty illustrative hands, with figures of all the cards, conclude the volume.

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POPULAR MISCELLANY.

Geological Survey-Work in Minnesota. —The law of 1872, under which the Geological Survey of Minnesota was instituted, was intended, according to Prof. N. H. Winchell, to place the survey in close connection with the State University; and the professorship of Geology and Mineralogy in the university was maintained for six years at the expense of the survey fund. From it the museum of the university has obtained the nucleuses of growing geological, zoölogical, and archæological collections. The survey was supported by legislative appropriations till the revenue from the sale of salt-springs lands supplied their place. The economic side of the enterprise has been kept in mind constantly, though it has not been conspicuous. "The annual reports embody common facts, and description cast in a semi-scientific mold. They are addressed primarily to a home constituency, in order to show them the utility of the work of the survey. As the survey becomes grounded in the good-will of our own citizens, it is strengthened for doing more advanced work, and at the same time finds a constituency that is ready to welcome more strictly scientific publications." Among the most important results of the work of the survey have been the saving of the salt-springs lands from being devoured by speculative enterprises; dissuading citizens, by the publication of correct information on the subject, from making fruitless searches for coal; calling attention to the economic resources of the State; and showing the people how to secure cheaply a supply of pure water for domestic purposes. The scientific results, while not including any great new discoveries, have been numerous, and all have a place in the elucidation of geological theory. The unfinished work of the survey lies in the northern part of the State, and, embracing the crystalline rocks and the various questions of economic and technical geology that pertain to them, is the most important as well as the most difficult and costly part of its work.

Summer Courses at Harvard. — The courses of summer instruction at Harvard University will include four courses in chemistry (general elementary chemistry, qualitative analysis, quantitative analysis, and organic chemistry); courses in experimental physics and botany, geology (elementary and advanced); topography, French, German, and physical training; and courses at the medical school. A general course of lectures on methods of instruction will be given in addition by teachers in the several departments represented by the schools, open free to all members of the summer schools. Persons are admitted as special students in the university who desire to pursue for a year or more the study of some particular subject; and who, having received a high-school or academy training, wish to follow for one or more years a course of liberal study preparatory to some profession or to the walks of active life. The summer courses will open on different days between June 30th and July 9th, inclusive.

Nature's Earth-Carving.—As the tools used by Nature in carving the earth, Dr. Archibald Geikie enumerates air, rain, rivers, springs, and frost. Exposure to the air changes the hardest rocks. Cracks form in them which receive the rain and are enlarged by freezing in winter, to increase the effect of the next season's rain in washing away the surface. No rock wears away faster than white marble, the destruction of which is speeded by the carbonic acid in the air. The waste in a century sometimes amounts to a third of an inch in thickness. The more compact kinds of sandstone endure better, and in tombstones still, after the lapse of two centuries, show marks of the chisel. Sandstones, however, usually con-

tain a layer more soluble than the rest, along which the rock splits and peels. Compact rocks like granite are traversed by parallel joints on which the weather acts destructively; and the less compact clays, dried to powder, are blown by the wind and swept more rapidly into rivers, lakes, and the sea. The rain-streams, always running over the same channels, furrow the hill-side and wear it away still more rapidly; and a sheep-walk in a few years may become a deep ravine. The material carried down, when spread at lower levels, helps to form plains like meadows, and these in time may be cut through and partially carried away. Streams descending from peaty regions are charged with carbonic acid, and destructive to limestone. In all mountain regions the rivers are liable to enormous increase in volume from heavy rainfalls, when they carry off proportionately larger quantities of earth. The work of springs is like that of rain and rivers. The sink-holes in limestone regions carry the water down underground to do a similar work there; and this underground flow of water often helps in the production of landslips, especially when the ground is covered with bowlder-clay.

Teaching the "New Botany."—In the "New Botany," as described by Prof. W. J. Beal, in Garden and Forest, pupils are set to studying plants before books. Previous to the first lesson, "each pupil is furnished or told where to procure some specimen for study. If it is winter, and flowers or growing plants can not be had, give each a branch of a tree or shrub, which may be two feet long. The examination of these is made during the usual time for preparing lessons, and not while the class is before the teacher. For the first recitation each is to tell what he has discovered. The specimens are not in sight during the recitation. In learning the lesson, books are not used; for, if they are used, no books will contain a quarter of what the pupil can see for himself. If there is time, each member of the class is allowed a chance to mention anything not named by any of the rest. The pupils are not told what they can see for themselves. An effort is made to keep them working after something which they have not yet discovered. If two members disagree on any point, on the next day, after further study, they are requested to bring in all the proofs they can, to sustain their different conclusions. Give other specimens for the next lesson, keep reviewing, and generalize as details and facts accumulate. I like to give two species for careful comparison. . . . After a few weeks, reviews may be made in connection with chapters in some book. I make it a rule to give pupils specimens for study and comparison regarding every chapter in Gray's Structural Botany before the book-lesson is studied. I place no stress on making these investigations in the order in which the chapters of a text-book are arranged. Free use is made of our botanic garden, the crops in the vegetable-garden, fields, and experiment station, and the thickets along the river. Special topics are often assigned, in which each student has to go many times to observe and record observations on his growing plant." Illustrations by drawing are a prominent feature of the whole course.

Leaning Towers.—The leaning tower of Pisa is not the only building of its kind. There are many towers in northern Italy that deviate from the perpendicular, so that a writer has spoken of the country as "a land of towers staggering in all directions like tipsy men"; and there are in England few spires of any great altitude that are quite upright. The inclination of the Italian towers is a result of the character of the foundation soil, and of mistakes in building. The soil and subsoil of northern Italy down to the water-level are composed of rounded stones brought down by torrents and rivers from the Alps. A broad foundation is a primary condition of the stability of buildings erected upon it. The builders of the towers had classic models in their eyes, and did not contemplate the broadening of bases or the adding of buttresses to insure stability. Consulting appearances, and not venturing to depart from the conventional, they built straight up. The pressure concentrated on the narrow base was too much for the shifting stones beneath. They yielded at the weaker points, and the towers bent over. If the builders had minded the example of their Gothic neighbors and widened their bases, the load would have been more evenly

distributed over more ground, and the deviation from the perpendicular would not have been so obvious. There are many leaning towers in Bologna, inclining in all directions; and few of the campaniles of Venice are perfectly upright.

Palæolithic Implements in the United States.—The Palæolithic implements of the District of Columbia, and indeed from all over the United States, as described by Mr. Thomas Wilson, are always chipped, never polished; are almond-shaped, oval, or sometimes approaching a circle; have their cutting edge at or toward the smaller end, and not, as in the Neolithic specimens, toward the broad end; are frequently made of pebbles, and with the original surface sometimes left unworked in places; and are exceedingly thick compared with their width, so much so as to make it apparent that they were never intended to have a shaft or handle after the fashion of the axe or arrow or spear-head. They were usually made of quartz, quartzite, or argillite; while the Neolithic man used any material that would grind to a smooth surface. They are not known to have been used by the American Indian, who when found by Europeans was in the Neolithic stage. Of the thousands of Indian mounds, cemeteries, graves, and monuments which have been explored, not one has ever yielded these Palæolithic implements. The articles found in the District of Columbia are of the same type as Palæolithic implements found in the Trenton gravels; at Little Falls, Minn.; in Jackson County, Ind.; at Claymount, Del.; and at Loveland, Ohio; and all together contribute to prove that a real Palæolithic period existed in the United States.

Sharing of Earnings.—After several years of experimenting, Mr. Alfred Dolge, of Dolgeville, Herkimer County, New York, has decided upon a plan for sharing with his employés the earnings of his manufacturing business. A share of the net earnings of the business is to be set aside each year, and applied for the benefit of the employés in three ways—as pensions, insurance, and endowment. Every male employé who becomes unable to work after a continuous service of ten years receives a pension equal to fifty per cent of his wages. Each three years of service over ten up to twenty-five, increases the pension ten per cent. A disabling accident happening to an employé while on duty entitles him to a fifty-per-cent pension, even if he has not served ten years. Employés are also entitled to a life-insurance policy for one thousand dollars after five years' service, to a second one after ten years, and a third after fifteen years. For each employé rejected by the insurance company with which the house contracts, and for those entering the service of the house when over forty years old, thirty-five dollars a year is deposited instead of the policy. After five years of consecutive service, also, an account is opened with each employé, upon which he will be credited at the end of each year according as the manufacturing record shows that he has earned more than has been paid him in the form of wages. If through gross carelessness any employé has caused the house a loss, such loss will be charged against this account. This endowment money shall be payable when the employé reaches the age of sixty years, or upon his death. Against this account the employé may obtain a loan by paying interest and furnishing collateral security. Mr. Dolge is convinced that this scheme is superior to what is known as profit-sharing, because it is not projected from any idea of benevolence, but is based on self-interest. It places the employé on the same level with his employer; it puts him on his mettle, and rewards him according to his own merit. The main objection which Mr. Dolge has to the ordinary profit-sharing plan is that it gives the lazy and incompetent workman the same percentage in addition to his wages as it gives to the intelligent and industrious employé, who has perhaps earned for his employer twice as much as the former.

Science and Poetry.—Writing upon Browning's Science in Poet Lore, Dr. Edward Berdoe maintains that, "other things being equal, the poet who knows his natural history, his botany, and his physical science, will write better poetry than he who knows nothing of these things." The author has for some years been pointing out how Browning's scientific imagination and learning enhance the value of his poetic work and his

claims to recognition as a great teacher of the nineteenth century. His work is "as distinctively the product of the age of science as Petrarch's of the revival of learning." There is not a mood of the human mind, Dr. Berdoe continues, which is beyond the power of this poet to analyze and explain. "Analysis with him becomes invective. He is 'the maker,' because he is so great an analyst. Analysis with genius such as his leads to synthesis, and for this he is called a scientific poet." His poems teem with instances of the influence which modern scientific discoveries have exercised upon his genius, and this possibly is one element in their obscurity. As Max Müller has said that neither Tennyson nor Browning could be understood without an acquaintance with the Greek and Roman classics, so "in Browning's case a knowledge of the physical sciences is also demanded of us; but this only shows that Browning is in advance of his time, as a leader of men should be. The age can not be very distant when an acquaintance with science will be as common as a knowledge of the ancient classics. Then we shall hear less of Browning's obscurity. Browning's theory of life is eminently in accord with the teachings of evolution and development." It is scientific because he goes into its purpose, and what to the pessimist is infinite mystery is replete with law and order to him. A large number of citations from Browning's poems are given to confirm and illustrate these positions.

Recognition of Pictures by Animals.—A correspondent of The Spectator owns a fox-terrier that had been cured of a tendency to run sheep by judicious punishment. Some time afterward the dog, which had been left in a room for a few minutes with an unfinished painting of sheep and sheep-dogs in the snow, was found gazing intently at the picture and showing all the signs of canine excitement. As the figures of the sheep were only eight or ten inches in length, the owner believed that the dog must have understood that they were supposed to be at a distance from him. The dogs in the picture he apparently entirely ignored. Another correspondent of the same journal tells of a dog who, when shown a life-sized figure of a cat worked in wools on a screen, made a rush for it, and but for his master's clutching him firmly by the collar the screen would have been torn to shreds. A cat is also mentioned who sprang at a bird which her mistress had painted on a fire-screen, and a dog, who disliked being washed, that when shown a large picture of a child scrubbing a fox-terrier in a tub turned away his head ruefully and would not look at his "brother in adversity." These instances are put forward as evidence of animal intelligence. But do they not rather serve as measures of the inferiority of brute to human intelligence? For the dog or cat in each case was deceived by an artificial representation on the flat which would not deceive a human being.

Antiquity of Submarine Warfare.—The efficiency of submarine mines or batteries and of guard-boats and shore defenses is augmented to a wonderful degree when the two systems are made to supplement one another. The combination of them affords the only means now known for compelling the enemy to long and cautious operations when he would like to carry his purpose at a blow. It is possible to evade or defy either system alone, but "even the most dashing commander would hesitate to run past forts and batteries when every channel is alive with destructive charges." The efficiency of mines depends on every part of their arrangement being complete; and while the laying of them is simple enough, they are in practice subject to difficulties and complications from weather, wind, tides, currents, fogs, and shifting ground, that can not be foreseen. These cunning inventions of explosive engines, rams, and torpedoes, though they seem so new and scientific, had their counterparts in the devices of the past. The spar torpedo-boats were like the Greek fire-boats which were described in the thirteenth century as old. The mobile torpedo-boat had its prototype in those drifting or secretly propelled infernal machines that figured in the water-fights of two or three hundred years ago. Fixed submarine mines were described by Gianbaptista Porta in 1608. The principles of these systems are old; all that is new in them is contained in the "modern improvements" and more perfect adaptations. The systematic application of submarine warfare, however, dates from the second half of

this century. Louis XIV would have nothing to do with it. Napoleon discouraged Fulton's efforts, because they favored the art of defense as against his offensive operations; and in England Pitt was blamed for experimenting with Fulton's devices because it was encouraging a mode of warfare which, if successful, would be destructive to English supremacy of the seas.

Astronomy on Lake Tanganyika.—According to Père Vyncke, a French missionary, the negroes on the western side of Lake Tanganyika, although the sun passes over their heads twice a year, take no notice of his course, and have no idea of the solar year; but the moon plays an important part in their life. They celebrate its renewing by beating drums, firing shots, and shouting. The new moon is hailed with general dances by most of the African tribes. To keep the run of its age they have a bundle of twenty-eight or thirty sticks, of which they take out one each day. They consult the stars to determine the times for agricultural work, fishing, etc. The rising of the Pleiades marks the sowing season, and is celebrated by dances and festivals in honor of the dead; and the constellation is called *kili*, or seeds. The milky way is called the line of drought and rain, because the rainy season begins when it rises at sunset. The rising of Orion's belt gives the time for catching a certain fish. Another star, which Père Vyncke does not identify, is called by a name signifying pounding manioc, because that operation is begun when it is at the zenith. Aldebaran is called the Northern and Sirius the Southern Gem. The Centaur, the Southern Cross, and the Ship, including the beautiful star Canopus, which is not visible in the north, are called by names signifying "paths" and "tens," because they point the way to the south pole and are composed of a large number of stars.

Voracity of a Pike.—The following story is told by a correspondent of Land and Water: "I and some friends were fishing in a small river in Hertfordshire, and, sport being poor, were watching a family of moorhens, just hatched. One of the fledglings, venturing too far out, was carried down a swift run, but managed to paddle into an eddy. No sooner, however, was the little creature in this supposed haven of refuge, than there was a swirling movement from below, a quick snap, and the fledgling disappeared in the jaws of a pike. Later on a second chick got carried away and was also swallowed by the pike, and very soon afterward, in spite of one rescue on our parts, a third was sacrificed. This was more than we could stand, and a spinning minnow, very poorly adapted for pike-fishing, was produced. At the second cast the lure was taken, and, fate being propitious, the gut escaped the pike's sharp teeth. Result, a fish of four pounds only. When landed, the last-taken chick fell out of the pike's mouth with an expiring gasp still in it, and, on the fish being held head downward and shaken, the other two made their appearance."

The Ordeal by chewing Rice.—The East Indian method of discovering a thief by the ordeal of chewing dry pounded rice has almost disappeared of late. A case of its successful application many years ago, to discover who had stolen a gold watch that was missing, is described in Chambers's Journal. A native official, who was employed by the government for detecting thieves by the rice ordeal, was called in to conduct the process. The loser of the watch was one of four young Englishmen who occupied a house together. All the servants of the establishment, some forty-odd in number, were seated in two rows on the ground in one of the long verandas of the house. A small piece of green plantain-leaf was first placed in each man's hands. The thief-detector then went round with a bowl of pounded rice, like flour, and with a wooden spoon poured a quantity into the open mouth of each servant. The order was given that each man was, within five minutes, to chew the rice-flour to a pasty mass, and eject it on to his plantain-leaf. Most of the men set to work with a will, though a few were rather frightened at first; but long before the five minutes had elapsed almost every one had got through with the operation, and held the evidence of his innocence in his hands. But why are so many eyes turned toward one man, who sits back as if anxious to avoid observation? We also look, and there is the favorite serv-

ant of the loser of the watch, with his face almost convulsed, and trying in vain to get the rice-flour out of his mouth. His lips are dry, and his glands refuse to produce the saliva which is needed to moisten the rice-flour. At last the detector's eyes glare upon him, and pointing at him with his long, bony finger, he says solemnly, "There is the thief!" The victim quails and grovels on the floor before him; he faintly appeals to his master for forgiveness, and promises that he will restore the watch. The convicted thief slowly rises, and requesting his master to follow him, goes to the well in the garden, and produces the gold watch from under a loose brick. This operation savors of magic, but it has a psycho-physiological explanation. It is one of the instances of the influence of mind over body: the anxiety of the culprit evidently arresting the flow from the salivary glands.

Position of the Expert Witness. — The expert, the Chemical News has said, occupies an anomalous position in court. Technically, he is a mere witness; practically, he is something between a witness and an advocate, sharing the responsibilities of both, but without the privileges of the latter. He has to instruct counsel before the trial and to prompt him during its course. But in cross-examination he is the more open to insult, because the court does not see clearly how he arrives at his conclusions, and suspects whatever it does not understand. Hence, not a few of the most eminent men in every department of science distinctly and peremptorily refuse to be mixed up in any affair which may expose them to cross-examination. "I will investigate the matter, if you wish it, and will give you a report for your guidance, but only on the distinct understanding that I am not to enter the witness-box." Such in substance is the decision of not a few men of the highest reputation and the most sterling integrity. Certainly it is not for the interests of justice to render it impossible for such men to give the court the benefit of their knowledge. Further, the spectacle of two men of standing contradicting or seeming to contradict each other, in the interest of their respective clients, is a grave scandal. Thus, our present mode of dealing with scientific evidence is found on all hands unsatisfactory. The outside public is scandalized; experts are indignant; and the bench and the bar share this feeling, but are disposed to blame the individual rather than condemn the system. It was proposed, as a remedy for this evil, that "the expert should be the adviser of the court, no longer acting in the interest of either party. Above all things, he must be exempt from cross-examination. His evidence, or rather his conclusions, should be given in writing, and accepted just as are the decisions of the bench on points of law."

Half a Century of Inventions.—"Those of us not yet fifty years of age have probably lived in the most important and intellectually progressive period of human history," says Iron, and names the following as a few of the inventions and discoveries which have originated or been made practical within the past half-century: Ocean steamships, railways, street-car lines, the telegraph, ocean cable, telephone, phonograph; photography, and a score of new methods of picture-making; aniline colors, kerosene, electric lights, steam fire-engines, chemical fire-extinguishers; anæsthetics and painless surgery; gun-cotton, nitroglycerin, dynamite, and a host of other explosives; aluminum, magnesium, and other new metals; electro-plating, spectrum analysis, and the spectroscope; andiphone, pneumatic tubes, electric motors, electric railways, electric bells, type-writers, steam heating, steam and hydraulic elevators, vestibule cars, cantilever bridges. To these may be added the vulcanizing of rubber, the Bessemer steel process, bicycles, the "Monitor" type of war-vessels, the dynamite gun, and doubtless the list does not now include all of the most important even.

Science in the Laundry.—While washing is declared to be as much a chemical process as dyeing or pattern-printing, there has been very little application of scientific principles to it. The finishing up is held in the laundries to be more important, but is really less so than the preliminary processes of actual cleansing. These are four in number—digesting or soaking, washing, rinsing, and drying. In cleansing, two sources of contamination are to be kept in view—the dirt that comes from without and settles on the

clothes, and the soiling that is caused by transpiration from the body. It is most important that the elements of bodily soil be removed, and this is probably accomplished quite as much in the drying as in the washing. We judge of the purity of clothes by their "sweetness." This is, to a large extent, proportioned to the completeness with which they have been acted upon by the atmosphere, or by its great oxidizing agent ozone, and is consequently dependent on the atmospheric conditions under which they are dried. The lesson is, that atmospheric drying is the best, and that laundry drying by artificial heat can not be depended upon to do its work, unless pains are taken to give a free circulation of ozonized air.

Voice-Figures on Glass. — A curious mode of decorating glass is practiced by an English lady, Mrs. Watts Hughes. The figures which she produces are shell-like forms, trumpet and snake like shapes, twisted together and combined, and crossed in various directions by lines, but not exactly like anything in nature. The instrument by which these lines are drawn is the voice, and the method of procedure differs for different figures. For a daisy-like figure, Mrs. Hughes prepares a paste of flake-white powder-color and water. On a thin membrane of India-rubber stretched over one end of a ring, resembling a napkin-ring, she spreads a little water, to which some of the flake-white paste is added, and thus floated all over the disk. This ring is inserted into the lower end of a tube turned up like the letter J. She then sings into the upper end of the tube a low note, firm but not very loud. Tiny globules of the paste are thrown up into the air by the vibration of the membrane induced by the sound, and fall back upon the center of the disk, making a little round heap, like the center of a daisy. Mrs. Hughes then sings a note of a different character from the first, when from the round center of white paste will fly out, at unequal distances, little tentative star-like jets. Sometimes two or three abortive attempts will have been made, when suddenly a symmetrical row of petals will start out and create with the center a dainty daisy-like figure. The pansy form is produced somewhat in the same way as the daisy, but more water is put on the disk in proportion to the paste, and the note is sung differently. In singing the shell and trumpet figures, the paste is made with Prussian blue, madder lake, or other pigment whose weight and character suit it to the vibrations of the particular note to be sung. Glass is rubbed over with the paste when the figures are to be called out upon it as well as the membrane. With a small piece of glass, Mrs. Hughes uses a bent-up tube and moves the glass rapidly round on the disk. Should the glass be too large to hold in the hand, she uses a straight tube, and sings the note while moving it round or along the glass. Specimens of this work were shown in the "Arts and Crafts Exhibition," at London, last fall, and panes decorated in this way form the lower part of the windows in Mrs. Hughes's Home for Little Boys, at Islington. The explanation of the phenomenon is that the particles of coloring-matter are thrown off from the vibrating parts of the membrane and collect on the nodal lines—the lines of no vibration. The nodal lines of vibrating membranes were first thoroughly studied by Savart.

Taming the Puma.—To show what may be done in the way of training the puma, or Rocky Mountain lion, usually deemed one of the most intractable of animals, William Lant Carpenter writes to "Nature" an account of one he has recently seen at Livingston, Montana. She is now three years old, and was raised from a cub by Mr. W. F. Wittich, who devoted eighteen months to training her. He now has her under complete control. "The beast not having been fed for twenty-four hours, he trailed pieces of raw meat over her nose and mouth, which the puma never attempted to eat until the word was given, as to a dog. Occasional attempts were made, but a twist of the ear by Mr. Wittich was sufficient to control her. When meat was placed a few yards off, the puma fetched it by word of command, and permitted the meat to be taken from her mouth by Mr. Wittich, who fondled her as he would a cat. A very fine dog, a cross between a pure setter and a pure St. Bernard, five years old, named 'Bruce,' is on intimate and even affectionate terms with the puma, who allowed him to remove meat

placed upon her jaws, and to eat it. On one occasion the puma (who is often allowed to range the house), the dog, and Mr. Wittich slept together in the same bed. . . . In training her he has chiefly used the whip, which she feels only on the nose, ear, and under the tail; he assures me he has made his own teeth meet through her skin in several other parts of her body without her showing any signs of sensation. Her memory is short, and three weeks' intermission of the performance necessitates much extra training and trouble."

Beet-Sugar in Germany.—Baron Lucius's report on the crisis in the beet-sugar industry of Germany, from 1884 to 1887, brings out the curious fact that the largest number of roots were used in the manufacture of sugar during 1884–'85, when the crisis was most intense. This is accounted for by the fact that preparations for extending the manufacture and the cultivation of the roots had been made before prices declined. The increase was also promoted by the general adoption of the processes of diffusion, and the production of a beet-root richer in saccharine matter. The production of molasses was also considerably increased. The Germans are estimated to consume eight kilogrammes of sugar per head; and the exports have increased in greater proportion than the production.

NOTES.

Prof. Samuel Cushman, Apiarist of the Rhode Island Agricultural Experiment Station, maintains, as the result of personal observation, that bees do no damage to growing or fair fruit. The juice of fruit is, in fact, injurious to them; and they do not attack sound fruit, but only bruised fruit, or that which has been previously injured by other insects. Every member present of the State Horticultural Society, before which Prof. Cushman read his paper, sustained him in this view. The author spoke also of the useful agency of insects, particularly of bees, in aiding the fertilization of flowers, and in contributing to cross-fertilization.

In Prof. John Bach McMaster's course of instruction in the history of the United States in the University of Pennsylvania, text-books are eschewed, and lectures and a printed syllabus take their place. Students are referred, whenever it is possible, to printed documents for information; and maps and diagrams, prepared by the members of the classes, are required to accompany the theses.

The Royal Geographical Society has awarded its Royal Medals to Emin Pasha and to Lieutenant Younghusband—to the latter, for his journey from Manchuria over the Mustagh Pass to Cashmere and India, of which we have published an account; the Cuthbert Peek grant to Mr. E. C. Hare, for observations on the physical geography of Lake Tanganyika; the Murchison grant to Signor Vittorio Sella, in consideration of his recent journey in the Caucasus; and the Gill memorial to Mr. C. M. Woodford, for his expeditions to the Solomon Islands, of which a report has been published in the Monthly.

Extract from Stephen Girard's will, dated February 16, 1830, in his eighty-first year: "The orphans admitted into the college shall be instructed in the various branches of a sound education, comprehending reading, writing, grammar, arithmetic, navigation, geography, surveying, practical mathematics, astronomy; natural, chemical, and experimental philosophy, the French and Spanish languages (I do not forbid, but I do not recommend, the Greek and Latin languages), and such other learning and science as the capacities of the several scholars may merit or warrant. *I would have them taught facts and things, rather than words or signs;* and especially I desire that by every proper means a pure attachment to our republican institutions and to the sacred rights of conscience, as guaranteed by our happy constitutions, shall be formed and fostered in the minds of the scholars." It is interesting to see how distinctly this notably clear-headed man set forth the requirements of a real education, which are only beginning to be adopted sixty years after he penned these words.

In the opinion of Sir T. Spencer Wells, President of an English Sanitary Association, much of the outcry about dangers from women taking up men's work is breath wasted. He thinks women capable of a great deal more than they have been accustomed to do in times past. "If overwork sometimes leads to disease, it is more morally wholesome to work into it than to lounge into it." For every example of disease of mind or body induced by mental overstrain he has seen twenty "where evils equally to be deplored are caused in young women by want of mental occupation, by deficient exercise, too luxurious living, and too much amusement or excitement."

Movements for the abolition of war are likely to gather increasing strength from the growing and universal expensiveness of the system. In the middle ages but little harm was done by war, except to the fighters. If a territory was overrun and devastated, there

was but little fixed capital to be damaged, and the next year's production of the soil would be as good as ever. But the effects of to-day's wars in civilized countries are felt, not by the belligerents only, but to the very ends of the earth. The network of commerce is so complicated and extensive that any suffering felt by one member of the family of nations is shared in more or less by all. The Lancashire weavers probably suffered more from the stoppage of the cotton supply in our civil war than they would have done by any contingency in a war between England and Germany or France.

THE researches of Mr. Charles B. Plowright into the distribution of calculous disease in England make apparent a correspondence between it and gout, and some likeness with the distribution of diabetes, but little or no parallelism with that of rheumatism and albuminuria. When compared with the rainfall map of the country, the disease seems to prevail most where there is least rain. So in Ireland, where the rainfall is very heavy, fatality from calculus is rare. Exposure to a dry atmosphere means, of course, more loss of fluids to the body than immersion in a moist atmosphere; and it has been proved experimentally that immersion in water of a lower temperature than the body of itself lessens the acidity of the urine.

SEVERAL agencies deleterious to health are mentioned by M. Raymondeau as confronting the workers in Limoges china-ware. They are forced to occupy a position that promotes a spinal curvature; the dust arising in the early operations of crushing and grinding the quartz is deleterious to the lungs; the work in preparing the paste is done on a panned floor over which water flows continuously, or under conditions favorable to the propagation of the maladies of dampness; those who have to place the prepared paste in the ovens are exposed to the danger of an escape of sulphuric-acid gas; and those who turn, polish, and dust the china suffer from the action of dust on their bronchial tubes.

SOME interesting facts were furnished some time ago by English hatters respecting the sizes of men's hats. The "size" is a mean between the length and breadth of the hat; thus, measurements of seven inches and a half by six inches and a half would give No. 7, and so on. The usual size for an adult Englishman is No. 7. Germans have round heads, Malays small ones. The heads of Portuguese average from six inches and seven eighths to seven inches; those of Spaniards are a little larger. The heads of Japanese excel the English average. Men that have much to do with horses are said to have the smallest heads; and a rough relation appears to exist between the size of the headdress and the mental capacity.

AMONG the peculiar geological features of Palestine, as described by Prof. Hull, are traces of old sea margins two hundred feet above the present sea margins, and the evidences that an arm of the Mediterranean had at one time occupied the valley of the Nile as far as the First Cataract, when Africa was probably an island. It is also made probable that, at the time of the Exodus, the Red Sea ran up into the Bitter Lakes. In illustration of the great changes that have taken place in the elevation of the land eastward of these lakes, it was mentioned that the waters of the Jordan Valley once stood at 1,292 feet above their present height.

A SMALL exposure of peridotite in Pike County, Ark., described by Messrs. Branner and Brackett, of the State Geological Survey, is regarded as important in the suggestion it offers respecting the time and character of the disturbing influences by means of which the region was sunk toward the end of the Cretaceous period beneath the ocean, and as interesting because it is the third reported occurrence of picrite-porphyry in the United States. The entire exposure is 2,400 feet long by 1,600 feet wide.

A MEETING of the International Congress of Hygiene and Demography is arranged for, to be held in London in 1890. Sir Douglas Galton is president of the organizing committee.

THREE asteroids which have been discovered since the 1st of January, 1890, bring the number of these worldlets that have been identified up to 290. Most of the more recent discoveries seem to have been made by specialists who pursue the search for asteroids as their chief work. Mr. Luther, who discovered No. 288, has been about forty years at the business, and this is his twenty-fourth planet. M. Charlois, the discoverer of No. 289, has detected six of these. No. 290 is M. Palissa's seventieth asteroid, although he has been looking for them only since 1874. Mr. Peters, of Clinton, New York, has discovered forty-eight. The brothers Henri discovered seven each, but of late years their attention has been turned from this subject to that of photographing the sky.

THE collection of birds from the Galapagos Archipelago, made in connection with the voyage of the steamer Albatross in 1882, is of special interest, for the reason that two islands are represented in it upon which no collections had been made before; and several new species have thus been added to science; while other islands have been carefully examined. From Mr. Robert Ridgway's description of these collections—published among the Scientific Results of the Expedition—it appears that the avifauna of the islands is not yet exhausted as a field for promising research in the problem of the derivative origin of species.

PRESERVING fruits and vegetables by drying in the sun has been practiced from time immemorial. Within historical times drying in kilns has been introduced, and within the present century compression of the dried product has been added to the process by the French. Immense quantities of dried and compressed fruits and vegetables are prepared for the British Army and Navy. In the Crimean War the following proportions for mixed vegetables were decided upon and are still adhered to: potato forty per cent, carrot thirty, cabbage ten, turnip ten, and seasoning herbs (onion, leek, celery, parsley, parsnip, etc.) ten per cent. The vegetables are also put up separately to meet special wants in various parts of the British possessions. After being dried they are compressed to about one eighth their original bulk, and formed into small slabs which are packed in soldered tins stamped inside with the year of manufacture.

THE American Geologist states that the largest gold-mine in the world is in Alaska. It is lighted throughout by electricity and is worked day and night. An offer of sixteen million dollars for this mine has been refused.

OBITUARY NOTES.

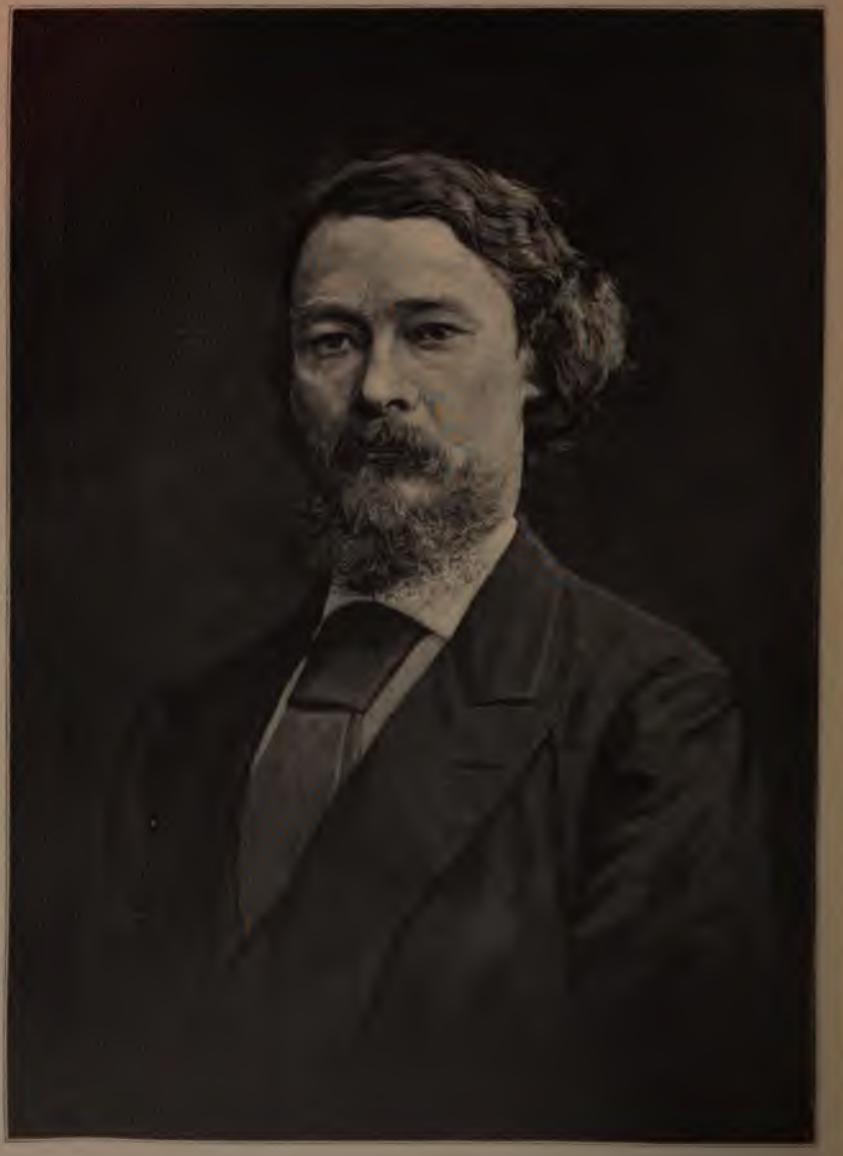
THE death of the German Count Keyserling made a large breach in the little circle of working araneologists, or students of spiders. It was known that he had left a large amount of manuscript for the concluding parts of his work, Die Spinnen Amerikas, and this, it was feared, would be lost to science. But the publishers, with praiseworthy enterprise, have resolved to complete Keyserling's work as far as possible after his original plan. They failed, however, to find any one in Europe who would edit the finished manuscripts and complete the fourth volume, which treats of the *Epeiridæ*. In this emergency they solicited the aid of Dr. George Marx, of Washington, D. C., who has at last consented to undertake the task. Being a thorough German scholar and a well-furnished araneologist, Dr. Marx is admirably equipped for this duty. A large part of Count Keyserling's manuscript, which was in a good degree of forwardness, has already been edited and will soon be ready to transmit to Germany. Dr. Marx will then edit the notes upon the *Orbitelariæ* and add descriptions of the species which Keyserling had not reached at the time of his death. He will thus contribute about one third of the matter in what will constitute Volume IV of Die Spinnen Amerikas.

EUGÈNE PELIGOT, an eminent French chemist, died April 8th, in the eightieth year of his age. He was most distinguished in the field of agricultural and economic chemistry. As a pupil of Dumas, he published his first paper in 1836, on wood-spirit and its derivatives. He was Professor of Chemistry successively in the *École Centrale* and the *Conservatoire des Arts et Metiers*, and of Analytical Chemistry applied to Agriculture in the National Agronomic Institute; and for forty years held a responsible position at the Mint. He first isolated Uranium. He was author of eighty papers on subjects of mineral and organic chemistry that bore relation to pure science, industry, agriculture, and hygiene. The most important of these were on the sugars.

SIR JOHN HENRY LEFROY, a British officer distinguished in military life and in science, died in Lewarn, England, April 11th, in the seventy-ninth year of his age. He was Director of the Magnetical and Meteorological Observatory at St. Helena in 1840 and 1841, and removed to a similar position in Toronto in 1842. During the next year he made a magnetic survey of the interior of North America from Montreal to the Arctic Circle. In 1854 and 1855 he was scientific adviser to the Duke of Newcastle at the War Office on subjects of artillery and inventions. He has since held several high military appointments.

AMONG the deaths of scientific men since the beginning of the year, which have not been specially noticed here, are those of Dr. L. Taczanowski, of Warsaw, author of works or papers on the ornithology of Peru, Poland, Siberia, and Corea; Otto Rosenberger, of Halle, best known in connection with his work on Halley's comet; Prof. Neumayr, the geologist, of Vienna; Dr. Gulia, Professor of Botany, Hygiene, and Forensic Medicine in the Royal University of Valetta, Malta, and author of a flora of that island; Dr. F. Hauck, algologist, and author of the volume on marine algæ in the new edition of Rabenhorst's Cryptogamic Flora of Germany; Lorenzo Respighi, of the Campidoglio Observatory, Rome; and Father Stephen Joseph Perry, of the Stonyhurst Observatory, England, who died in Demerara, where he had gone to observe the eclipse of December 22, 1889.

MR. JAMES NASMYTH, the eminent English mechanical engineer and inventor of the steam hammer, died in London, May 7th, aged eighty-two years. He was born in Edinburgh, the son of a distinguished artist. When a boy he made a small steam-engine for grinding his father's colors. In 1829 he became an assistant to Mr. Maudsley in his private workshop in London. After Mr. Maudsley's death he made himself a set of tools and began business, with a small capital, at Manchester. Besides the steam hammer he invented a safety-ladle for foundries, a ventilator for mines; a steam-engine for screw steamers, and a rolling-mill. He retired from business in 1857 and became an amateur astronomical observer, giving particular attention to the sun and the moon, and to astronomical photography. His monograph on the moon, prepared in conjunction with Dr. Carpenter, of Greenwich, is the most valuable English work on the subject.



RUDOLPH KOENIG.

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COMMON SENSE APPLIED TO THE TARIFF QUESTION.

By EDWARD ATKINSON.

I.

ACCORDING to the English theory and practice of representative government, from which our own methods have been derived (subject, however, to some variations of doubtful expediency), it is the function of a Minister of Finance, named in this country Secretary of the Treasury, to prepare a budget or estimate of income and expenditures. At each session of the British Parliament specific expenditures are recommended, and specific sources of revenue are set off, which have been carefully computed, so that it may be hoped or expected that revenue and expenditure will balance.

Any one conversant with the financial history of Great Britain will long since have ceased to wonder at the accuracy of these estimates. If a probable surplus in revenue is expected from existing taxation, the Chancellor of the Exchequer frames such measures of relief from taxation as may be assumed to yield the greatest benefit to the tax-payers. If, on the other hand, any extraordinary expenses are to be provided for in the ensuing year, then specific additions to taxation are recommended in order to provide the necessary ways and means. Under these conditions the opening speech of the Chancellor of the Exchequer when he presents the budget, so called, becomes the subject of most careful public attention. The reputation of leaders in Parliament is established or is lost by their ability to deal with financial questions. Ministries stand or fall according to the ability of the leader of the party to satisfy the public of his sound judgment in dealing with the matter of public taxation. Thus, while the reputation of the leaders of the House of Commons on either side

is made or marred by their power of dealing with revenue questions, yet, in order to enable them to do so with intelligence, permanent officials are kept in office in the civil service of Government through all party changes. These permanent secretaries are charged with the duty of keeping the public accounts in such a way that, in spite even of revolutionary changes in party politics, the continuity of the financial history and of the records of account may be maintained with absolute integrity of purpose, so that there may be no break in the established system, whoever may be in power.

The names of Robert Giffen, permanent Secretary of the Board of Trade; of Sir Thomas H. Farrar, who for more than fifty years occupied a most important position in the service of the Treasury of Great Britain; and the name of the late Sir Louis Mallet, for many years permanent Secretary of the India Board, are well known to every economic student both here and abroad.

When one fully comprehends these conditions under which the conduct of the finances of Great Britain has been carried on for many generations, it no longer remains a matter of surprise that the knowledge of these subjects among the people of Great Britain is far above that of the people in our own country. The financial debates in Parliament are also so far above those of our own Congress as to leave little room for comparison. With a few conspicuous exceptions among our Representatives and Senators, there is hardly a man capable of making a financial speech that is worth any attention on the part of a student. There are many speeches delivered which contain valuable information, but these are mostly compiled in the party bureaus either by the clerks of committees or by others who are conversant with affairs, generally men who are competent to meet the requisitions of members when they desire to address their constituents through the medium of the Congressional Record.

When any great financial debate comes up in the British Parliament there is hardly a speech made which is not worth close attention, or which does not stand for the convictions of the speaker, based on his own knowledge of the subject.

The proceedings in our Congress offer a severe contrast. Witness the customary course in the treatment of financial questions. The annual report of the Secretary of the Treasury is laid upon the table of the several committees, who immediately ignore all the recommendations of the Secretary. The Committee on Appropriations immediately proceed to recommend the expenditures without any regard to revenue; while the Finance Committee in the Senate and the Ways and Means Committee in the House at once proceed to consider revenue measures without any reference whatever to ways and means, and with scarcely any atten-

tion to the appropriations, except when the appropriations become so extravagant as to hazard the success of the party in power.

Such have been the conditions under which revenue measures have been treated by the present Congress, finally resulting in an act the avowed purpose of which is to diminish the revenue by increasing taxation, and to divert the increase of taxation from the Treasury of the United States to the support of private enterprises, either by direct bounty, as is proposed in the case of sugar, or by indirect contribution, as in the case of tin plates and other matters.

What other description can be given to a revenue measure framed upon the new theory of protecting—that is to say, of providing by public taxation the ways and means by which a specific branch of private industry may be supported, with the incidental purpose of yielding a lessening revenue to the public treasury?

It has therefore seemed to me expedient that one who has been studying the financial questions of this country for more than twenty-five years might rightly assume the functions with which the permanent civil officers of the British Parliament are charged, viz., that of preparing a budget by sorting national expenditures according to their kind, and by placing specific sources of revenue against the different elements of the public appropriations.

The writer may not presume to rival the Chancellor of the Exchequer or the Secretary of the Treasury. It is their function to deal as statesmen with the facts that are prepared for them by those who are conversant with all the existing financial conditions.

The time has come when it is the duty of every man who may be assumed to have some exact knowledge upon the subject of taxation, to present his views when called upon in a simple, plain way, without regard to his own private interests, whatever they may be.

Before coming to the main subject, I beg to say that I should myself find it somewhat difficult to characterize my essay by any distinctive title which would be theoretically correct. I observe that my work, my figures, and my views are quoted by one party as often as by the other; and I also find that exceptions are taken to my presentation of this subject in about even measure by the *doctrinaires* on the free trade and the *intolerants* on the protective side alike. I may perhaps characterize this essay as one "upon the protection of domestic industry, and the development of the home market by exemption from unnecessary taxation"; or, for short, I will call it "Common Sense applied to the Tariff Question."

The motive of this address may be given in the form of a simple account current, which might be entitled "Uncle Sam in Account Current with his People." We, his people, may rightly charge Uncle Sam with the contributions which we are called upon to make in order to meet the obligations of Government.

We may credit Uncle Sam with the expenditures that are required to meet the obligations of the war, and also for the conduct of the Government, equitably administered with the least interference with the freely chosen pursuits of the people:

This account is adjusted to the prospective revenue, predicated on receipts to date in the year 1890.

I will therefore make Uncle Sam debtor to the amount of the war taxes which are collected under the internal revenue system on whisky.....	$78,000,000
To the amount of the war taxes which are collected under the internal revenue system on fermented liquors.....	27,000,000
To the amount of the war taxes which are collected under the internal revenue system on tobacco.....	33,000,000
To the amount of the war taxes which are collected under the tariff on sugar and molasses.....	60,000,000
	$198,000,000
Add for elasticity in 1890 and 1891.....	2,000,000
	$200,000,000

REVENUE FROM WAR TAXES.

We will credit Uncle Sam with the annual obligation for the payment of pensions already granted, now rated at $65,000,000, adding for arrears $35,000,000.....	$100,000,000
We may now hope that the current annual pensions, aside from arrears, may not get beyond the sum named above, $65,000,000. It will be observed that the payment of arrears is the liquidation of a debt now in process of being audited, and that on payment the liquidation of arrears of pensions is final.	
We will credit Uncle Sam the amount of interest which must be paid on the war debt.....	31,500,000
	$131,500,000
We will credit Uncle Sam with the amount which should be applied to the sinking fund for the extinction of the war debt.....	48,500,000
	$180,000,000

When we balance these war taxes against the war expenses, we find a surplus which may be carried forward to meet the ordinary expenses of the Government, $20,000,000, and this surplus will be subject to rapid increase with the growth of population and the presently diminishing burden of debt and pensions.*

* Between the date of the preparation of this treatise in May, 1890, when it was written for submission to a private club, and the correction of the proof for publication, a Pension Act has been passed which may for a time take up this excess of war taxes above the previous war expenses, and even a little more. It is believed, however, from the best information that can be obtained, that even under this act the current annual pensions will not exceed $100,000,000 a year.

On the other hand, the elasticity of the revenue which is due to the growth of the population and progress of the country, will be likely to render the avails of the taxes on liquor, tobacco, and sugar quite sufficient to meet even the extravagant pension-list under this and previous acts, and the diminishing amount of interest on the public debt, even without stopping the contribution to the sinking-fund, or providing for it in any other way. In English practice, which we might well adopt, such an extravagant Pension Act as that which has now been added to our previous ample provision would have been accompanied by a proposed tax intended to meet it specifically, like an income-tax or a renewal of the duty on tea and coffee. Such is not our habit of legislation, although it well might be.

In the analysis which I shall present in this essay, I shall endeavor to prove how readily the remainder of the necessary contributions of the people to the support of the civil government may be collected wholly from taxes on articles of luxury or of voluntary use, or on the finer textiles which are dependent on style and fancy for their sale, without putting any tax of any kind upon any commodity, either partly manufactured, crude or raw material, which is necessary in the processes of our domestic industry. I shall endeavor to show how the removal of $40,000,000 to $50,000,000 of obnoxious taxes now imposed upon this class of materials may open the way to products, sales, wages, and profits amounting to at least $500,000,000 a year, which such a policy would add to the resources of this nation, to be divided equitably among the people in the form of additional wages and profits; thus promoting domestic industry, enlarging the home market, raising both the rate and the purchasing power of wages, and increasing profits.

In the renewed discussion of the tariff question it has become unpleasantly manifest that men are taking positions which may soon lead to a very bitter conflict, in which contest mutual recrimination will cause distrust and may prevent any suitable reform of the tariff being carried into effect, as it ought to be, by the common consent and governed by the common sense of all men who are directly interested in the matter, and by the application of that sound business judgment which should be applied to this business question.

It is very true that there are moral as well as political considerations underlying the whole problem of the tariff. Such being the case, it is a matter of duty for the citizen who will not be directly affected either in property or in person in any considerable measure by any changes in our tariff legislation, yet to watch it and to give it a true direction. The effect of tariff measures, considered from the money point of view in their burden or their benefit, has, I believe, been very much overrated; but the evil of dependence upon legislation in the conduct of industry can not be exaggerated.

In the way in which this subject of tariff reform is now being treated, whatever is done will be badly done; therefore, great harm

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In this connection, however, it may well be remembered that the interest on our public debt at its highest point amounted to more than $150,000,000. It is not probable that pensions and interest will exceed, if they equal, this sum. This great obligation for interest did not prove to be inconsistent with a large excess of revenue which has been so wisely applied to the reduction of our debt. The attempt to spend the public money in order to prevent the reduction of the tariff has probably culminated; but the increase of the obligation for pensions renders a scientific or common-sense treatment of the tariff question yet more necessary than it was before.

will ensue before any true adjustment of duties can be made to present conditions, although both political parties now agree that great changes are absolutely necessary. How can we separate this question from party politics?

It has always seemed to me very absurd, even grotesquely so, that men who are accustomed to put confidence in each other in the conduct of all their private affairs as well as in their town and city work; who trust each other in every walk of life; who serve together on boards of directors in savings banks, insurance companies, trust companies, and the like, and who adjust all differences of judgment in a reasonable manner, yet when this subject of tariff legislation comes up impute to each other, or else sustain newspapers that impute to each other, every form of insincerity, untruth, fraud, and malignant selfishness.

There is nothing so foolish as the imputations which are put upon the advocates of free trade by their opponents, except the corresponding imputations put by their opponents upon the mass of the advocates of protection, of lack of care or consideration for the public welfare. The masses are sincere on either side, however time serving and incapable their political representatives may be.

Conceive what the conditions of this country would be if the ideas which the Cobden Club represents had not prevailed, and if our wheat and dairy products were boycotted as our pork is in Germany; or if our cotton were taxed as it was before the markets of Great Britain were made free. In 1880 there were nearly eight million men occupied in agriculture; now there are ten million, more or less. In 1880 seventeen per cent of the product of agriculture found a home market only by sale for export; now about twelve per cent. If we did not exchange this product for other products, we could not sell it. If we could not sell it for export, over a million men would be driven from the field to the factory and to the workshop.

When I listen to the foolish talk of partisans on either side, and witness the ill-judged contention on the tariff question, I am sometimes inclined to exclaim, "A plague on both your houses!" Is it not time that this method of imputing wholly selfish or bad motives should cease, and that any one or every one who indulges in it should be held in contempt as an example of intellectual stupefaction?

It was well said by President Cleveland when he so bravely brought the subject to an issue, "What we have to deal with is a condition and not a theory."

Let us consider this condition, find out exactly what it is, and then see what we have to do in the matter, each man on his own account.

I have never known any intelligent advocate of a tariff for

protection who did not consider free trade as the ultimate objective point in all tariff legislation. I do not know any man of any intellectual standing, in public or in private life, who does not now look upon free trade as the true objective point of all tariff legislation. All sensible men hold that there are existing conditions which make it inconsistent with the public welfare to adopt revolutionary free-trade measures at the present time; but they all accept the fundamental principle, provided certain conditions precedent can be established in a safe and proper way.

The difference among intelligent men at the present time is only as to the time when it may be suitable to begin tariff reform in this direction, and upon the method of such reform. So it has always been. It is only the first step that costs. Gladstone once said, doubtless recalling his own experience and change of views, "The road to free trade is like the way to virtue, the first step the most painful, the last the most profitable."

The conditions which now obtain in this country correspond very closely to those which existed in Great Britain in 1842, at the time when Sir Robert Peel was compelled to modify and ultimately to change all his previous conceptions upon this subject, and to become the leader in the great reform of the British tariff which ended in the present system, sometimes called that of British free trade. This system is not free trade in an abstract or in an absolute sense, because Great Britain raises a large revenue from duties upon foreign imports, and will probably be compelled to do so for very many generations in order to sustain the burden of her great debt. We shall also be compelled to raise a large part of our revenue from duties upon imports, for one generation; but I will presently prove that our advantage in conditions is so great that it may enable us within even less than one generation to adopt absolute free trade if it shall become expedient to do so, except so far as it may continue to be necessary to tax the import of spirits in order to maintain the revenue derived from an excise measure. Whether or not absolute free trade may be desirable or expedient, it will be time enough to determine when the opportunity is offered. What we have to deal with now is our present condition and not this theory, as President Cleveland so well put it.

In one of Sir Robert Peel's great speeches which he made long after he had entered upon this course, he spoke as follows, in explanation of his course at the beginning of the reform of the tariff:

"I stated, and I am ready to repeat that statement, that if we had to deal with a new society in which those intricate and complicated interests which grow up under institutions like those in the midst of which we live, had found no existence, the true abstract principle would be to buy in the cheapest market and to sell

in the dearest. And yet it is quite clear that it would be utterly impossible to apply that principle in a state of society such as that in which we live, without a due consideration of the interests which have grown up under the protection of former laws. While contending for the justice of the abstract principle, we may at the same time admit the necessity of applying it partially; and I think the proper object is first of all to lay the foundation of good laws, to provide the way for gradual improvements, which may thus be introduced without giving a shock to existing interests. If you do give a shock to these interests, you create prejudices against the principles themselves, and only aggravate the distress. This is the principle on which we attempted to proceed in the preparation of the tariff."

Our present conditions correspond almost exactly to this statement; and the logic of events is bringing almost all economic students, many legislators, and also nearly all the intelligent leaders in the manufacturing and mechanic arts to the same conclusion to which Sir Robert Peel was brought by the logic of events when he took office in 1840; especially by the very disastrous condition to which Great Britain had been brought under an obstructive tariff policy the effect of which culminated at that date.

One may also refer to one of the greatest speeches that Daniel Webster ever made—a speech which he delivered at Faneuil Hall in October, 1820, at a meeting which had been called to resist an increase of duties above the very moderate revenue tariff of 1816, which was then in force—a meeting such as ought to be held now to protest against a worse measure. This meeting was called by men whose names are familiar to every Boston man—by William Gray, James Perkins, Nathan Appleton, Abbott Lawrence, Joseph Sewell, George Bond, Thomas Wigglesworth, William Sturgis, and by many others whose names have been household words among the merchants and manufacturers of Massachusetts for generations. In dealing with the high tariff measure, which was then being forced upon Massachusetts against her will, Webster said:

"To individuals this policy is as injurious as it is to government. A system of artificial government protection leads the people to too much reliance upon government. If left to their own choice of pursuits, they depend on their own skill and their own industry; but if government essentially affects their occupations by its systems of bounties and preferences, it is natural that when in distress they should call on the government for relief. Hence, a perpetual contest follows, carried on between the different interests of society. Agriculturists taxed to-day to sustain manufactures—commerce taxed to-morrow to sustain agriculture—and then impositions perhaps on both manufactures and agri-

culture to support commerce. And when government has exhausted its invention in these modes of legislation, it finds the result less favorable than the original and natural state and course of things. I can hardly conceive of anything worse than a policy which should place the great interests of this country in hostility to one another, a policy which should keep them in constant conflict, and bring them every year to fight their battles in the committee-rooms of the House of Representatives at Washington.

"An appeal has been made to the patriotic feelings of the nation. It has been said we are not independent so long as we receive these commodities from other nations. He could not see the force of this appeal. He did not perceive how the exchange of commodities between nations, when mutually and equally advantageous, rendered one dependent on the other, in any manner derogatory to its interest or dignity. A dependence of this sort exists everywhere, among individuals as well as nations. Indeed, the whole fabric of civilization, all the improvements which distinguish cultivated society from savage life, rest on a dependence of this kind. He thought the argument drawn from the necessity of providing means of defense in war had been pressed quite too far. It was enough that we had a capacity to produce such means when occasion should call. The reasoning assumes that in war no means of defense or annoyance can be probably obtained, or not without great difficulty, except from our own materials or manufactures. He doubted whether there was much ground for that assumption. Nations had hitherto obtained military means in the midst of war, from commerce. But, at any rate, as it was acknowledged on all hands that the country possessed the capacity of supplying itself whenever it saw fit to make the sacrifice; and he did not see why the necessity of making it should be anticipated; why should we now change our daily habits and occupations, with great loss and inconvenience, merely because it is possible that some change may hereafter become necessary? We should act equally wise, he thought, if we were to decide that although we are now quite well, and with very good appetites, yet as it was possible we might one day be sick, we would therefore now sell all our food and lay up physic."

In another part of this great speech Webster, with prophetic insight, foretold how the whole face of New England industry and society would be changed for the worse if this high tariff policy were forced into effect by sectional votes. Two generations have passed since Webster's prophetic words in Faneuil Hall in 1820. This speech was given just seventy years ago. Do we not now witness the representatives of different industries fighting their battles in the committee-rooms of the House of Representatives at Washington? Do we not to-day witness agriculture

taxed in order to sustain manufactures; commerce taxed to sustain agriculture; and impositions proposed upon both agriculture and manufactures to sustain commerce by subsidies and bounties?

Again quoting President Cleveland, "It is a condition and not a theory which we are called upon to meet." What is that condition? Here are two parties in Congress each attempting to deal with this great problem, each claiming to be equally in earnest to promote domestic industry, to develop the home market, and to protect the workmen of this country. The representatives of each of these two parties are elected by great bodies of voters who are equally honest and sincere in their efforts, or who have persuaded themselves that they are, and that the future prosperity of the country will depend upon their having their way. In this position we merely find conditions of the same kind that have been met before. In every great emergency each party claims to be the savior of the country; but the country saves itself in spite of parties, as it did in the civil war. Its material progress continues on its stupendous way in spite of the little petty obstructions which are interposed by those who believe they can manage all the affairs of the people better than they can manage them for themselves.

Between these two parties, if this is to be a party question, each one of us must make a choice when we vote or when we select the party with which we must act. Both these parties claim to protect domestic industry in the measures which they propose; but their proposed measures differ fundamentally. On the Republican side the policy is to tax every foreign product, crude, partly manufactured, or finished, of which a similar product has been or can be established in this country, without regard to the effect of such a tax on other branches of industry. Their avowed purpose is to impose taxes "for protection with incidental revenue," in order to render this country, as they term it, "independent of all others." It does not matter to them whether a branch of industry which might be set up exists at the present time or not. For instance, the Republican tariff bill will double the tax on tin plates without regard to the use to which these tin plates are to be put. No regard is paid to the nature of the work which must be done in order to ascertain whether it is desirable or not. The promoters of this measure simply say, Here is something which may be made in this country for which we now exchange our surplus products. The work ought to be done here, even if its establishment costs twice or thrice what it is worth!

Now, if the most superficial examination had been given to the kind of work which is to be done in dipping sheets of iron or steel into melted tin by hand, no machine having been invented for displacing this process, it would have been found that it is an art for which the people of Wales not only possess an inherited apti-

tude, but also that it is one which could not be established in this country without importing the Welshmen to do it, because we have so many opportunities for work, under more wholesome and profitable conditions, that we can not afford to do such work, no matter what the inducement may be.

In other words, the policy advocated by the Republican party is one of privation and not of protection, and it is avowedly sustained by many prominent Republicans against their avowed conviction of what would be beneficial, and merely because an assumed party necessity compels them to surrender their own convictions of right.

On the other side, the policy advocated by the Democratic party for protecting American industry is to exempt from taxation all articles of foreign origin which, either in a crude or in a partly manufactured state, are necessary or useful in the processes of domestic industry. They hold that our capacity to produce food which the world must have or suffer from hunger; cotton, without which the commerce of nations would be crippled; oil which we can not burn ourselves; goods, wares, tools, and implements of many varieties, the best of their kind; all our great crops made and all our goods being produced or manufactured at the highest rates of wages and yet at the lowest cost as compared with any other country in the world, enables us to exchange these products for the crude or partly manufactured materials, the raw wool, the tin plates, and for whatever we need which foreign laborers or workmen desire to sell in exchange. They hold that if we can get for one day's work at high wages in our own country the product of ten days' work even of foreign paupers, we can not afford to do that kind of work for ourselves; they hold that by such exchange we may gain yet higher wages and larger profits, the wider we can extend our commerce on such terms.

They hold that what we receive from other countries in exchange for the excess of our products which we can not consume, becomes as much a part of our own product as if these necessary commodities had been produced on our own soil or from our own mines and forests.

They hold that the home market is most fully established when all possible obstructions to the mutual service of nations are removed and the utmost facility given to the people of every land to send to our home market what we need and to buy in our home market what we do not want for our own use.

That is free trade, qualified by the necessity of obtaining a revenue from duties on selected imports. When we have attained it we may wonder why any one ever dreaded it; and if I may once more repeat my favorite quotation from Mr. Gladstone, "Then will the ships that pass between this land and that be like the shuttle of the loom, weaving the web of concord among the nations."

Between these two lines of policy every voter will soon be compelled to choose, and by making this choice a great change in the relative influence and importance of one party or the other will be brought about unless we can separate this question from party politics.

In order that this choice in each man's method of action may be rightly made, it now becomes expedient to treat the method of tariff reform simply as a business question and not as a party question. Parties which were thrown out of all true relation to the future by the issues of the past ought to be reorganized so as to carry into effect the conclusions to which voters have been brought by their convictions of right on the issues of the future. When they are renovated in this manner one may expect a great many men who are now holding prominent positions to be relegated to private life. Their places will be taken by men who are competent to apply reason, judgment, and common sense in their methods of fiscal legislation, a faculty or capacity which has been denied to many of those whom the circumstances of the past have thrown up into positions of considerable prominence which they have continued to hold up to the present time, but for which they are incapable.

When dealing with the tariff question in this way it is probable that every intelligent man who is conversant with affairs and who has given any attention to the reform of the tariff will agree wholly or very nearly with the following statement:

1. The present tariff is confused and inconsistent with itself in many of its provisions.

2. Some of its provisions which were especially intended to promote specific domestic manufactures have been either so erroneously framed or so construed in the Treasury Department as to discriminate against the very branches of industry which they were intended to promote.

3. These badly framed or badly administered provisions of the tariff acts promote undervaluation, evasions of duty, and fraud; but their worst effect is to discourage honest manufacturers and merchants alike by the uncertainty which they cause as to the future course of trade, as well as by the opportunities which they give both to dishonest employers, importers, and unscrupulous manufacturers to evade the laws.

I may venture to relate a little story of how tariffs are made and unmade. It is one of many incidents which made me a free-trader in principle.

I found an apparent inequality in the tariff act many years since, adversely affecting a branch of industry in which I had invested a few thousand dollars. I framed an amendment and sent it to a prominent Congressman from Massachusetts, who was on

the Committee of Ways and Means, explaining the reasons why it should be adopted. No hearings were given, and it seemed to be so fair, as I also thought it was, that it was adopted and went into the tariff with some other amendments. In it I used the technical word "hank." That Congress dissolved presently on the 4th of March. A few days later, the principal appraiser of the Boston Custom-House called upon me and put to me the question, "What is a hank?" I told him it was a skein of cotton yarn eight hundred and forty yards long; adding, "Why do you ask?" "Because," said he, "some damned fool has put a duty in the tariff by the hank, and, if we can't get around it, an established and important branch of domestic industry will be ruined." I asked for an explanation; and upon the development of the facts I said, "Well, you used the right term, and I am the man." Then said the appraiser, "You must see if there is no way to get around your amendment." I studied the matter carefully, and invented a way for avoiding or evading my own act. The threatened industry was saved, but I lost my little investment, as I deserved to, for putting my money into a business which I did not understand.

But this was not the end. Matters went on smoothly for two or three years, when there was a change of appraisers. The new man contested my construction of my own amendment, and undertook to enforce the law in accordance with the real intention. An appeal was taken to the Secretary of the Treasury. By good luck at that time I happened to call upon the collector; he, knowing my familiarity with the art but knowing nothing of my previous connection with the act, nominated me as merchant appraiser to decide the case on its merits. I of course sustained the practice of the first appraiser who had consulted me, and again the threatened industry was saved; by sustaining my own evasion of my own act, justice was done.

This is but one of many incidents which many men could relate; it is but an example of many great wrongs which have been done that have never been righted.

I have stated the conditions which render important changes in our tariff acts an absolute necessity. It is probable that all intelligent manufacturers and merchants, and all legislators except those who are bound by mere party ties in considering these changes, would agree upon the following propositions:

a. In the preparation of measures for collecting duties upon imports, such discrimination ought to be used as will most fully promote domestic industry and protect American labor from injury.

b. In framing such tariff measures, discrimination ought to be used so as to develop the home market for domestic products to the utmost; so far as this can be done by the exercise of judgment in framing tariff acts.

c. It is neither lawful nor expedient to impose duties upon imports without exercising such discrimination in the choice of subjects of taxation as will most fully promote the public interest, irrespective of private gain.

d. It is neither lawful nor expedient to frame measures for the collection of revenue from duties on imports for the purpose of raising or permanently maintaining the price of any given article above what it would otherwise be; except under the necessity of taxing such article for purposes of revenue only.

e. It is neither lawful nor expedient to put either a duty or a tax upon any crude or partly manufactured article which is necessary in the processes of domestic industry, by which large numbers of persons may be burdened, even if the interests of a lesser number might be for a time promoted.

If such are the conditions which we are now called upon to meet, and if such are the lines on which we are to work, then manifestly the first consideration must be given to sorting and classifying articles which are or may be imported, with a view to their use rather than with a view to the question whether or not they may be produced in this country. On the other hand, it must be admitted that there may have been some branches of industry which have been promoted by high duties and which may have been developed a little more rapidly than they would otherwise have been, under a high tariff, at the cost of the consumers for the time being. How shall they be treated?

It may be held that the position which has been assumed by most of the advocates of the protective system, I mean protectionists, according to the common acceptance of the meaning of that term, has been mainly due to the former misconception in regard to the source of wages, which was held even down to the time of Mill, and by him until a late period in his own life and work; to wit, a conception that wages are derived from a fund previously accumulated, and therefore from a "wage-fund" which might be to some extent under the control of capitalists by whom it should be administered, either in one direction or in another at their own choice. This mistaken conception of the source of wages leads to the further misconception that we must *make work*, or *provide work*, for a multitude, arbitrarily or willfully directing the force of capital in one way or another. What we really desire to do, what we really seek to attain, is that which is the purpose of all science and invention—not to make work, but to save work; to diminish the effort which is necessary to procure subsistence, shelter, and clothing, thereby increasing abundance. When we do that, it becomes necessary that there should be the widest possible and the freest possible exchange of services, or an exchange of product for product, of service for service, of product for serv-

ice, or of service for product, in order that those who are displaced from one kind of work by the application of science and invention may be most ready, able, and competent to take up some other kind of work less arduous, less exhausting, and more conducive to human welfare.

What is the object of exchange? How few people ever ask themselves that question! If each one of us did not save himself by exchange from some part of the necessary work required to sustain life, there would be no exchange; each one of us, and every other man, would live and work for himself alone. All this is elementary. It becomes perfectly clear when considered as between man and man. Does not the same rule govern the commerce of nations? What is the commerce of nations, except the sum of the exchanges between man and man? Unless each nation gains by the exchange, does not the trade stop? If both gain by the exchange, does it not hurt both to stop it by legislation? By obstructing exchange, we may make work where we might save it; but that nation loses most from such obstructions in which the greatest abundance of product is attained at the least cost of labor and at the highest rates of wages. If there were such a thing in the world as pauper labor, that nation which exchanged the greatest amount of the product of skilled labor for the greatest amount of the product of pauper labor would save itself the most work. Daniel Webster once said, when in his prime, "The people of this country can not afford to do for themselves what they can hire foreign paupers to do as well for them." This is true not only in respect to the price of labor, but to the kind and quality of the work which is to be done.

There are many branches of industry from which science has not yet removed the noxious or bad conditions of the work. Dipping sheets of iron or steel which have been treated with acid into melted tin for conversion into tin plates is one of the arts which it would be most undesirable to introduce into this country until, by way of science and invention, its noxious conditions have been removed: then it will come here itself; the conditions will then be equalized; we can then afford to take up what it would now be injudicious for us to undertake.

When we consider the obstructive and injurious effect of many of our taxes, light although they may be in money, we find that they are a heavier burden than those of almost any other nation except Russia, Turkey, and Spain.

They have not increased the profits in the arts which were intended to be promoted by their imposition, except for short or variable periods; they have reduced wages in the protected branches of industry below those which are attained in occupations which can not be subjected to foreign competition, while

they have kept the prices of most important materials, which are necessary in the processes of domestic industry, far above those of our competitors, promoting their prosperity and retarding our own progress.

Yet our enormous advantages in most of the conditions which are conducive to human welfare are such that we thrive. Our bad methods of taxation are like a pebble in the shoe of a runner, keeping him painfully in the second place, when, if relieved, he could lead the field without an effort.

It is due to these favorable conditions that the paradoxical form of statement represents an absolute truth—viz., that our high rates of wages are due to our very low cost of general production.

This leads us directly to the consideration of the conditions of production, especially in the manufacturing arts, from which our ample profits or high wages are or may be derived, if our moderate taxes are rightly adjusted to our conditions. We possess so great an advantage in our position and in our control of the production of metals, of fibers, and of food products, that there can, of course, be no equalization of wages in this country with those of others, because we could only equalize by reducing our own. The tendency of all the forces in action, when not artificially obstructed, is to raise the rate of wages, to diminish the margin of profits, and to equalize the conditions of working people to their great advantage. If we must wait for the equalization of wages to those of other countries, as is so often urged, before undertaking tariff reform, we may wait forever. It is our very advantage in high rates of wages and low cost of production which might enable us to proceed earnestly, safely, and surely to absolute free trade within less than a generation, and to adopt that policy for the very purpose, not of equalizing, but of maintaining our huge advantage over every other nation.

One may sometimes feel humiliated when one sees men of skill, capital, and ability trembling before the competition of what they call pauper labor. Every man of affairs, every manufacturer, every employer of labor, avoids low-priced or pauper labor in his own work as much as possible; he knows that it is costly; he knows that, when he can command skilled labor at the highest price which is warranted by the market for the product, he will do his work with that kind of labor at the least cost. When it becomes necessary to run works on short time and to discharge a part of the workmen, who are the ones discharged? Not the high-priced men; they can not be spared; it is the high-priced men whose work is not affected by hard times. Every man makes his own rate of wages by his skill, aptitude, and industry; and those who do the work in the best manner get constant employment. The incapable are sometimes subject to compulsory idle-

ness. In the factories I have known cases where all the looms were watched, and every weaver who did not reach a certain standard in her earnings was discharged because the mill could not afford to have poor weavers employed in it.

Yet, although we possess so many advantages within the limits of our own domain, there are some parts of the world which hold an advantage over us, especially in the production of some of the crude materials which are necessary in the processes of domestic industry. There are also many arts from which science has not yet removed the noxious conditions or the excessive labor. These arts we had better not undertake so long as we can buy their product with the excess of our crops of grain and cotton.

Again, there are some sections of this country which could be more adequately supplied with crude materials from Canada than they can be from Pennsylvania; New England, for instance, in respect to iron and coal. Our members of Congress sustain the policy which deprives us of the vast deposits of iron, coal, and even of other materials, which are lying unused in the Maritime Provinces. They tax the wool of Australia and South America; they propose to double the tax on tin plates; and they endeavor to promote the manufacture of burlaps and other coarse fabrics made of jute within our own limits.

The question of crude materials I have treated. The noxious conditions under which tin plates are made, I have referred to. The making of burlaps as it is now conducted in Dundee is one of the least desirable occupations that human beings can be called upon to follow; until it has been improved, we had better buy our burlaps with cotton than try to make them ourselves.

Even the finest fabrics which are suitable for taxation for revenue, such as Brussels laces and the like, are made by hand at the lowest wages and under the most abject conditions of life. The finest silks must be woven by hand, because the silk-worm does not spin his thread so evenly as to make it possible to weave it on the positive power-loom. In fact, in respect to many of these finer articles, which are perfectly suitable subjects for a tariff for revenue rather than for protection, there are elements to which no attention has been given; they specialize themselves even according to heredity or to peculiar conditions. The finest cotton yarns are spun in England, sent to France to be woven, sometimes transferred to Germany to be dyed; and brought back to England to be sold. Some of the finest linens are made by growing the flax in one place, spinning it in another, and weaving it in another, all far apart. We can not force the manufacture of flax in this country until we have a great surplus of population which shall be compelled to do the work which the Irish, the Belgians, and the French are now forced to do for us even at the lowest

wages. The preparation of the fine flax by rotting is noxious, and can only be worked at the lowest possible rates of wages paid for mere manual labor. We can better afford to raise flax for the seed and burn the stalks rather than to force American labor into un-American lines of work, in the preparation of the fiber by the existing noxious methods.

All these matters must be considered, and when considered they prove how futile, how impossible it is for a Congress composed of men who have little or no knowledge of the practical affairs of life, to attempt to regulate prices and wages, directly or indirectly, by the enactment of revenue acts.

I have named several articles which are necessary in the processes of our domestic industry, in which some other countries possess an advantage over us, such as tin plates, burlaps, and the treatment of flax. These advantages exist especially in respect to crude materials to which machinery has not yet been applied to any great extent; and of manufacturing processes in which the greater part of the work is done by hand. In hand-work the rate of wages may be, and often is, a fair standard of the cost of production. Hand-work here and elsewhere is that which earns least and can not be protected by any system of taxation of any kind.

We annually import, free of duty, $120,000,000 worth of articles of food, and $140,000,000 worth of crude or partly manufactured articles which are made use of in our domestic manufactures, because we can not yet afford to do the work which would be required in the production of these articles, since our own workmen can do so much better than to undertake the kind of work required.

But we also annually import, aside from sugar and molasses, $40,000,000 worth of the most necessary articles of food; and $130,000,000 worth of articles in a crude or partly manufactured condition which are absolutely necessary in the processes of our domestic industry, on which we impose duties or taxes amounting to about $50,000,000 a year. To that extent our workmen are placed at a disadvantage as compared with the workmen of other manufacturing countries in which most of these articles are admitted free.

The saving of this tax of about $50,000,000 a year would be but a very small matter were it not for the effect of this tax on foreign imports on the prices of many domestic products. Out of the $50,000,000 a year which has been collected on crude materials, about $4,000,000 has been gained to the Government from duties on iron ore and pig iron. An addition of twenty-five cents on each barrel of beer now produced would yield the same amount of revenue. If it were assessed upon the beer, the entire tax that the people pay would be secured by the Government, and the exact cost would be $4,000,000 revenue, with three per cent for the cost of collection by means of stamps.

Now, what has been the effect of the tax of $4,000,000 on the price of iron and steel in this country? Various computations have been made, the latest by Mr. A. B. Farquhar, of York, Pa., the largest exporter of agricultural machinery in this country, and perhaps one of the largest manufacturers of agricultural machinery in the world. He computes the actual difference in cost of iron and steel to the consumers in this country during the last ten years at about $700,000,000 or $70,000,000 a year. David A. Wells, making very large corrections for contingencies, estimates the difference in the cost of these metals to the consumers of this country, as compared to the consumers of Great Britain, at $560,000,000 for ten years, giving a little different period of time. My own computations, which have been made with the utmost care and which are based wholly upon the figures given by the Iron and Steel Association of this country, and of the Iron and Steel Institute of Great Britain, make the excess of price paid for iron and steel in this country as compared to others, in the years 1880 to 1889 inclusive, not less than $500,000,000 and probably $800,000,000. I may add that the effect of the tariff upon iron and steel has been much greater than in respect to other articles. This country now consumes thirty-five to forty per cent of the entire product of iron made in the civilized world. Our consumption at the present time is greater than the largest product of Great Britain in any year. No other country could possibly supply us. No other country could have supplied us for many years. But by the partial obstruction to our demand upon Great Britain and Germany, due to our own tariff, the price of iron and steel in Europe has been very greatly depressed. The tendency throughout the world has been to a rapid reduction both in cost and in the price of these metals, due to the application of revolutionary inventions. But the reduction in price in gold has been much greater in Great Britain than it has been in this country: consequently, by our own act we have protected the ship-builders, the machinists, and the tool-makers of other countries, while preventing the extension of these arts in our own country; even failing to retain our home market.

We import a considerable proportion of the products of iron and steel that we consume, sometimes in the form of railway-bars, yet more in the form of hardware, tools, and machinery. A first-class textile factory can not be equipped in this country without resort to the machine-shops of Great Britain for a very considerable part of the most necessary machinery.

Again, the burden of a tax upon crude materials is to be gauged, not by its ratio to the value of the product into which it might enter and does enter as a component material, but in ratio both to wages and profits in the arts in which it is needed. If we

artificially raise the cost of materials and are unable to control the price of the product into which these materials enter, then it often happens that we must keep the wages down in corresponding measure, or else give up the undertaking; and, again, a yet more subtle difficulty: if we can not make a profit over and above the cost of materials, the wages, and the general expenses, then no capital will be invested in that branch of industry, and no wages can be paid, for lack of profit.

Now, observe how subtle this matter is. Any conspicuous or important branch of industry which will pay ten per cent profit will attract capital and will be established; but if the tax on the crude material is even ten per cent upon the finished product, and this tax can not be paid without doing away with the profit, then that art stops, and the other ninety per cent which would be distributed among the workmen is lost to them, merely because there is a disadvantage of ten per cent in the cost of the material as compared to some other places.

Now, then, any one who is conversant with the complexity of all modern manufactures can not fail to be aware that the revenue which the Government derives of $50,000,000 on the crude or partly manufactured materials which we do import and which we do use in the processes of our domestic industry, may so much restrict that industry by increasing our own cost of production as to limit our home market both for domestic and foreign traffic, and may prevent the establishment of arts in which ten times as much, or $500,000,000, might be distributed among those who would do the work if these articles were free from taxation.

This is the consequence of the higher price of domestic products in this country or the lower price which prevails abroad for lack of competition.

The very worst effect of a duty on crude materials ensues when, according to its advocates, it is most successful. They hold that if, by our tax, the price is put down in a foreign country, then the foreigner pays the tax. There are no words suitable to apply to such folly. By that very depression in the price of pig iron and wool we have built up the manufactures and machine-shops of Europe, and have failed more and more to hold our home market even for the specific products of the loom and the forge.

Moreover, the price of some of the most necessary articles of our domestic products which enter into our domestic industry, notably iron and steel, are maintained far above what the price would be except for this system of taxation, although not, perhaps, to the full measure of the rate of duty which is assessed. Hence it follows that, owing to this higher price on the most necessary articles of consumption in the manufacturing and me-

chanic arts, we have been unable even to retain our home market for domestic manufactures, and have been cut off from any considerable share in the supply of other countries.

In a rough and ready way, it may be said that the cost of materials, in all the staple products of machinery or in manufactured goods, ranges from one half to three quarters the entire cost of the finished product. If the price of these materials is kept even ten per cent higher in this country than it is in others, then of course all profit may be cut off by that disparity, and, in spite of vain attempts to put on compensating duties, that art languishes, and we protect the foreigner rather than the American.

It will be remembered that no heavy stocks of food, fiber, or fabrics are now carried anywhere in the world, beyond the probable consumption of a single year or less. Hence it follows that, in respect to the import of materials which enter into the processes of our own work, whatever the price may be in any given year, whether high or low, if through our high tariff the consumers are subjected to a higher price than our competitors abroad, our industry languishes and foreign industry is protected.

I have said that there are two parties, each earnestly claiming to promote domestic industry. On the one side we find the Republican party advocating privation of foreign imports, without regard to the uses for which such articles are required, in order to protect the few specific branches of industry in which we do not yet excel other nations. On the other side we find the Democratic party advocating the protection of the domestic industry of all alike, by exempting from taxation every article which is necessary in the processes of domestic industry that we can procure in any other country in exchange for the excess of our cotton, corn, wheat, and other commodities, which, even at the highest wages obtained anywhere in the world, are yet produced at the lowest cost.

Such is the position of the question on which every voter will be called to decide in exerting his influence and in choosing whom he will support.

Such were the exact conditions in Great Britain in 1840, only worse, because the natural resources of Great Britain, both in respect to agriculture and mining, are so much less than our own.

The first measures of relief from taxation in Great Britain were practically instituted by Huskisson in 1824, when wool and some other crude materials were in part or wholly relieved from duties. The effect of this change, especially upon the product of domestic wool in Great Britain, was very beneficial; relief from duty gave the manufacturers of Great Britain the opportunity to buy all the wool which they would require for any kind of work, and the consequence was, that the demand for British wool in-

creased, and did not diminish, as the farmers feared. These measures of Huskisson, however, were purely tentative; and, subsequent to 1824, there was a great financial struggle in the process of restoring specie payment in the Bank of England, and in the bringing about conditions consistent with peace. The great Napoleonic wars in the early part of the century had thrown every art and industry out of its true relation. But the method of reform was not forced upon the attention of the people of Great Britain until the disastrous results of the attempt to regulate prices and wages by way of a high tariff, and the failure of this method of promoting domestic industry and of developing a home market had culminated in 1840.

In every history of this time, the picture of the condition of Great Britain is one of the most painful suffering on the part of most of the working people. The land was held in the hands of a very few great landholders who were protected by the corn laws, and who were thus enabled to charge high prices for necessary food. Great wealth had been accumulating during the period of war in the development of mines, works, and factories. Individual wealth existed in a measure never before witnessed; and this condition misled many legislators in this country; it deceived the very elect, and doubtless led Henry Clay and other champions of a high tariff to advocate the very policy which Great Britain was then being forced to give up by the disastrous results which had ensued. Underneath this outside show of prosperity, poverty, destitution, and want existed on every side; pauperism existed as never before or since among any English-speaking people.

At the time when Sir Robert Peel took office in 1840 it was clearly proved that the very measures which had been enacted for the purpose of establishing a home market and building up domestic manufactures "had destroyed that market by reducing the great mass of the population to beggary, destitution, and want." I quote the exact words of a contemporary observer.

Those who choose to discriminate between the leaders of the two parties of the present time may read the perversion of English history by James G. Blaine, in the North American Review; and the true picture which is given by General M. M. Trumbull.

It would be well worth while for any one who may have been misled by the common errors about the influences which brought Great Britain to reverse her policy in 1842, to read up the economic history of that period. It can be done in a very few days. All the facts are given by the radical Miss Martineau in her History of Fifty Years' Peace; by the Tory, Sir Stafford Northcote, in his Twenty Years' Financial Policy, explaining the changes which Peel brought about; by the economist John Noble's Fiscal Legislation in Great Britain; or in Carlyle's

Past and Present. The best summary is to be found in the little book published in Chicago in 1884, by General M. M. Trumbull, entitled The American Lesson of the Free Trade Struggle in England. In this book will be found the whole record of the condition of England from 1838 to 1846, after the panic of 1836 which originated in this country and spread to Great Britain had spent its force, down to the culmination in 1846 of the measures which Peel instituted but which were substantially completed by Gladstone in 1853. This history ought to be read by every man who desires to make up his mind how to act in this country at the present time. The logic of events is the same. We are repeating history. We are suffering, so far as it is in the power of legislators to stop the progress of this country, from injudicious methods of obstruction; and we may make progress in agriculture and in manufactures by "great leaps and bounds," as Gladstone put it, whenever we choose to adopt the policy which will soon be brought into action, whether we will or no, by the logic of necessity.

The basis of Peel's tariff reform in England was established by Joseph Hume, who, being appointed chairman of the committee in the House of Parliament, made a report on the tariff of Great Britain, which then covered about twelve hundred and fifty specific articles, at an average rate of about twenty-eight per cent on dutiable imports. In this report he first sorted imports, according to their use, under four heads:

Crude materials.

Partly manufactured materials.

Manufactured goods.

Articles of the nature of a luxury, like wines and tobacco.

It was a case of condition and not of theory which Sir Robert Peel was called upon to meet when he took office. He met that condition by discriminating in choosing the subjects of taxation in the tariff which he presented, placing in the free list all the little petty taxes or duties on which an agreement was readily made, and then either making free partly manufactured goods or greatly abating duties upon them, at the same time reducing the duties on finished products except those of the fourth class, viz., those of the nature of a luxury or voluntary use.

I had become so much impressed and influenced by the success of this method that, during the last few months of the administration of Secretary Hugh McCulloch, I suggested to him to class the imports of this country in a way corresponding to Hume's method. I gave him my reasons somewhat in this way, that in whatever manner, by whatever party, under whatever name the reform of our tariff should at a future day be taken up, it would of necessity be governed by the logic of the lines or classes on which these imports might then be sorted. The suggestion was

adopted. I made five classes; and since that date the fiscal statement of each year has been tabulated in that way.

I venture to incorporate at this point the statement of the imports under each of the heads named with the duties thereon. I take these figures from the last report of the Bureau of Statistics of the Treasurer of the United States for the fiscal year ending June 30, 1889.

IMPORTS ENTERED FOR CONSUMPTION.

Imports of Merchandise subdivided into Groups or Classes according to Degree of Manufacture and Uses.

In the following tables the extended classification for imports entered for consumption, embracing over a thousand articles and classes of articles, which is mainly an alphabetical arrangement with two grand subdivisions of free and dutiable articles, has been subdivided into the five following general groups or classes, according to the degree of manufacture and uses of the articles imported. It is hoped that the condensation of imports into these groups will in some measure aid and simplify the labors of those engaged in investigating the operations of our tariff laws.

For more extended explanation of this classification, see report of this office on Imported Merchandise entered for Consumption, 1887, page xxiv, etc.

CLASS A.—*Articles of food, and animals.*

CLASS B.—*Articles in a crude condition which enter into various processes of domestic industry.*

CLASS C.—*Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts.*

CLASS D.—*Manufactured articles, ready for consumption.*

CLASS E.—*Articles of voluntary use, luxuries, etc.*

The value of imported merchandise entered for consumption in the United States, with the amount of duty collected thereon added, for the year ending June 30, 1889, has been as follows:

CLASSES.	Values.	Per cent of total value.	Duty collected.	Per cent of total duty.	Total value and duty.
(A) Articles of food, and animals	$240,666,693	32·45	$66,568,932	30·44	$307,235,625
(B) Articles in a crude condition which enter into the various processes of domestic industry	172,134,716	23·22	15,363,625	7·02	187,498,341
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	84,354,509	11·38	22,195,095	10·15	106,549,604
(D) Articles manufactured, ready for consumption	147,596,641	19·91	68,683,765	31·40	216,280,406
(E) Articles of voluntary use, luxuries, etc.	96,678,839	13·04	45,890,357	20·99	142,569,196
Total	$741,431,398	100·00	$218,701,774	100·00	$960,133,172

This table does not show the cost of the imports landed in our ports. There are not included in the values of articles the cost of coverings, commissions, etc., excluded from the dutiable value by the act of March 3, 1883; nor freight charges from the country of importation, and undervaluations, the aggregate amount of which can not be estimated with any approximation to accuracy.

Imports entered for Consumption during the Year ending June 30, 1889, with accompanying Diagram, showing the Relative Values of the Respective Classes of Free and Dutiable Imports, and the Relation of the Duty collected on each Class to its Value.

CLASSES.	Value.	Per cent of total.	Diagram. [Scale: 1 inch = $100,000,000.]
Free of duty.			
(A) Articles of food, and animals	$119,400,491	46·34	
(B) Articles in a crude condition which enter into the various processes of domestic industry	110,706,[illegible]	42·15	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	12,494,100	4·87	
(D) Articles manufactured, ready for consumption	9,[illegible],911	3·83	
(E) Articles of luxury and [illegible], etc.	4,148,850	1·61	
Total	$[illegible],074,000	100·00	
Dutiable.			
(A) Articles of food, and animals	$191,[illegible],[illegible]	25·01	
(B) Articles in a crude condition which enter into the various processes of domestic industry	61,497,[illegible]	12·67	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	71,[illegible],404	14·69	
(D) Articles manufactured, ready for consumption	137,[illegible],[illegible]	28·47	
(E) Articles of luxury and [illegible], etc.	89,[illegible],[illegible]	18·[illegible]	
Total	$[illegible],[illegible],[illegible]	100·00	
Dutiable.	Duty collected		
(A) Articles of food, and animals	$[illegible],[illegible],[illegible]	30·44	
(B) Articles in a crude condition which enter into the various processes of domestic industry	[illegible],[illegible],[illegible]	7·02	
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts	[illegible],[illegible],[illegible]	10·15	
(D) Articles manufactured, ready for consumption	[illegible],[illegible],[illegible]	31·40	
(E) Articles of luxury and [illegible], etc.	[illegible],[illegible],[illegible]	20·99	
Total	$[illegible],[illegible],[illegible]	100·00	

Summary of Values of Imported Merchandise entered for Consumption, by Groups, according to Degree of Manufactures and Uses, from 1880 to 1889.

	Year ending June 30—	VALUE OF—		Total.	Duty.	Ad valorem rate on dutiable.	Per cent of total duty.	Per cent of total value.
		Free of duty.	Dutiable.					
						Per cent.	Per cent.	Per cent.
(A) Articles of food, and animals.	1880	$90,637,062	$108,528,901	$199,165,963	$52,305,551	48·19	28·67	31·73
	1881	90,372,067	125,984,270	216,356,337	58,748,703	46·63	30·35	33·25
	1882	82,244,581	147,876,926	230,121,507	63,325,109	42·82	29·37	32·13
	1883	78,565,246	135,834,124	214,399,370	58,556,188	43·11	27·26	30·59
	1884	92,589,286	132,186,969	224,726,255	59,185,172	44·75	31·15	33·66
	1885	86,559,991	107,706,369	194,266,360	61,695,247	57·28	34·75	33·52
	1886	83,752,303	112,453,925	196,206,228	61,064,714	54·87	32·42	31·28
	1887	99,188,773	112,273,076	211,456,849	67,998,334	60·57	32·97	30·94
	1888	104,291,336	115,114,040	219,395,376	64,393,790	56·00	30·16	30·80
	1889	119,403,491	121,263,202	240,666,693	66,568,992	54·90	30·44	32·45
(B) Articles in a crude condit'n which enter into the various processes of domestic industry.	1880	96,980,615	63,075,261	160,055,876	20,650,123	32·74	11·32	25·52
	1881	92,570,041	56,929,006	149,499,047	17,130,700	30·09	8·85	22·28
	1882	103,045,047	61,010,729	164,055,776	18,788,424	30·80	8·71	22·97
	1883	102,844,603	46,321,172	149,165,775	12,986,129	27·93	6·17	21·29
	1884	94,089,567	44,407,174	138,496,741	11,922,748	26·82	6·25	20·75
	1885	82,507,747	37,101,595	119,609,342	9,454,989	25·48	5·33	20·64
	1886	102,438,364	41,613,638	144,052,022	12,863,115	30·91	6·83	23·04
	1887	106,389,032	59,542,660	165,931,692	19,567,903	32·86	9·23	24·28
	1888	111,808,141	56,221,508	168,029,649	15,880,839	28·16	7·42	23·59
	1889	110,706,883	61,427,833	172,134,716	15,363,625	25·01	7·02	23·22
(C) Articles wholly or partially manufactured, for use as materials in the manufactures and mechanic arts.	1880	10,529,186	62,657,777	73,186,963	18,864,498	30·11	10·34	11·66
	1881	9,360,939	58,711,565	68,072,504	17,475,842	29·76	9·03	10·46
	1882	13,488,950	65,736,906	79,225,856	19,943,553	30·35	9·25	11·06
	1883	13,032,614	75,580,521	88,613,135	23,055,271	30·50	11·00	12·84
	1884	12,186,427	69,963,939	82,150,366	18,536,278	26·49	9·76	12·81
	1885	11,185,487	61,271,465	72,456,952	17,088,148	27·89	9·64	12·50
	1886	10,689,156	67,855,317	78,544,473	20,115,152	29·68	10·68	12·56
	1887	12,149,883	67,505,441	79,655,324	20,393,498	30·21	9·62	11·66
	1888	11,692,617	73,013,645	84,706,262	21,824,788	29·89	10·22	11·90
	1889	12,494,105	71,860,404	84,354,509	22,195,095	30·89	10·15	11·93
(D) Articles manufactured, ready for consumption.	1880	9,141,858	120,872,785	130,004,643	56,271,500	46·55	30·85	20·72
	1881	9,134,263	135,095,640	144,229,903	68,665,234	47·13	32·89	22·17
	1882	10,621,288	147,545,470	158,166,708	70,541,612	47·81	32·72	22·08
	1883	11,116,812	151,292,076	162,408,888	71,116,388	47·01	33·92	23·17
	1884	11,035,112	123,015,766	134,050,878	58,518,780	47·57	30·82	20·08
	1885	10,617,405	103,410,164	119,027,569	52,587,386	48·28	29·54	20·24
	1886	12,446,211	113,824,644	126,270,855	55,658,858	48·90	29·54	20·19
	1887	11,565,665	124,473,106	136,038,771	61,898,366	49·73	29·19	19·90
	1888	11,488,012	133,352,873	144,790,885	67,426,549	50·56	31·58	20·33
	1889	9,820,801	137,775,840	147,596,641	86,688,765	49·85	31·40	19·91
(E) Articles of voluntary use, luxuries, etc.	1880	770,479	64,371,367	65,141,826	34,323,490	53·32	18·82	10·58
	1881	1,120,102	71,341,106	72,461,208	36,541,082	51·22	18·88	11·14
	1882	1,322,164	83,321,935	84,644,099	43,018,973	51·63	19·95	11·82
	1883	1,354,014	84,888,491	86,242,505	43,995,723	51·83	20·98	12·21
	1884	1,429,873	86,721,276	88,151,149	41,732,067	48·12	21·98	12·20
	1885	2,041,604	72,178,227	74,219,831	36,698,820	50·84	20·69	12·81
	1886	2,204,735	78,080,511	80,285,246	38,682,583	49·58	20·53	12·83
	1887	3,805,306	86,581,089	90,386,345	42,174,328	48·74	19·89	13·22
	1888	4,874,746	90,451,708	95,326,454	44,033,886	48·70	20·65	13·38
	1889	4,149,350	92,529,489	96,678,839	45,890,357	49·60	20·99	13·04
Total.....	1880	208,049,180	419,506,091	627,555,271	182,416,162	43·48	.....	.....
	1881	202,557,412	448,061,587	650,618,999	193,561,011	43·20	.....	.....
	1882	210,721,980	505,491,966	716,213,946	215,617,671	42·66	.....	.....
	1883	206,913,289	493,916,884	700,829,673	209,659,699	42·45	.....	.....
	1884	211,330,265	456,295,124	667,575,389	189,844,995	41·61	.....	.....
	1885	192,912,234	386,667,820	579,580,054	177,512,550	45·86	.....	.....
	1886	211,530,759	413,778,055	625,308,814	188,379,397	45·55	.....	.....
	1887	233,093,659	450,395,322	683,488,981	212,032,424	47·10	.....	.....
	1888	244,104,852	468,143,774	712,248,626	218,509,902	45·63	.....	.....
	1889	256,574,630	484,856,768	741,431,398	218,701,774	45·18	.....	.....

Early in the administration of President Cleveland I ventured to suggest to Assistant Secretary Fairchild to carry back this classification from the year 1884, in which it was first established, to the year 1880, so that we now have the result of ten consecutive years, 1880 to 1889 inclusive, which I now submit for consideration. I think all will agree with me that no committee of any party or under any name can fail to be governed by the logic of these lines in preparing measures of tariff reform.

SANITARY WORK IN GREAT DISASTERS.

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PRESIDENT OF THE PENNSYLVANIA STATE BOARD OF HEALTH.

THE suggestions offered in this paper are derived from the experience of the past summer at Johnstown, Pa., and in the other flooded regions of the State, where a large share of the organization of the sanitary measures fell to the writer. Although one ninth of the inhabitants of the devastated district perished and were buried in the *débris,* along with thousands of domestic animals; and although typhoid fever, measles, and diphtheria existed in the district before the calamity, they never spread to any great extent, and certainly never became epidemic.

The region was a peculiarly difficult one in which to conduct sanitary relief. Along a narrow mountain valley for twenty miles were scattered some twenty-eight towns and villages, forming Johnstown. Of these, twenty were devastated by the flood, which left almost every village isolated from the others, all bridges and roads being destroyed, as also all horses and vehicles of the inhabitants, thus rendering communication extremely difficult or impossible. The members of the State Board of Health were unacquainted with the geography of the region, and with the local physicians, as well as with those who volunteered their services. There were no disinfectants on hand, and the whole appropriation of the Board for sanitary purposes was but two thousand dollars for the whole year. When, therefore, on June 1, 1889, representatives of the State Board of Health of Pennsylvania reached the desolated Conemaugh Valley, to do what could be done to prevent the occurrence and spread of disease among the exhausted and stricken survivors, the best estimates that could be hastily secured showed that ten thousand human beings, one thousand horses, one thousand cows, together with a great number of hogs, dogs, chickens, cats, etc., were drowned and buried in the *débris* at Johnstown, and in the drift-piles down the river, while ten thousand sufferers were without shelter, wet, hungry, and distracted. There were slime, mud, carcasses of domestic animals, and human bodies everywhere.

"No pen has yet fully described the condition that existed the next day after the waters of the South Fork Lake had swept the valley. The pen will never picture the desolation that existed, or tell of the difficulties that confronted the inhabitants of the stricken valley. The homes that were not swept away were left in the most unsanitary condition imaginable. The flood in many localities reached a height of thirty feet. This water contained

or was heavily laden with *débris* and every kind of filth, and whatever this water touched it contaminated. As a result, every house in the flooded district was filled to the second floor, in most cases, with offensive matter. In many cases dead animals were found in parlors, and scores of dead horses were removed from dwellings and business stands. Everything was covered with mud. There was not a place where the flood touched that man could lay his head with safety."

The State work began June 1st and ended October 12th. The result at Kernville, a ward of Johnstown, is a truthful index for the whole district. "With the concentration of twenty-five hundred people in three hundred and eighty houses, all subjected to intense mental strain by reason of the calamity and the radical changes in their habits of living, it is very gratifying to know that during the continuance of the Board's operations not a case of infectious disease developed in the district which should be attributed to bad sanitary condition." In the past history of national disasters we do not read of such gratifying results, but dire pestilence has too often followed great earthquakes, floods, fires, famine, and the disasters of war.

There are several measures not strictly sanitary, but most necessary, to which the sanitarian should give heed before his own special work occupies his attention. If the officers of the district have been lost, or in any way rendered inefficient, a strong government must be at once organized, and the district placed under efficient police control, that lawlessness and anarchy do not prevail. At Johnstown the people named a "dictator," who decided all questions of government and kept the region in order. The distress which lawlessness produces must not be tolerated. The organization of relief corps to succor the injured and dying, and to organize temporary hospitals, should receive next the attention of the sanitarian. So soon as the government is assured, and temporary relief is progressing satisfactorily, he may advise the proper committee as to what will be needed in the way of food, clothing, shelter, and medical stores. These will be required in large quantities; but in the United States, at least, we can safely rely upon the country at large to supply these things promptly. For shelter, tents can be had from the State Governors by applying to them.

At Johnstown the people did not like tents, preferring any kind of houses, and suffered great inconvenience from overcrowding rather than go into the tents. There were two forms of ready-made houses used—one, familiarly known as "Oklahomas," were of two sizes: the smaller, eighteen by ten feet, with one room, and a larger, eighteen by twenty-four feet, with two rooms; and the Hughes house, which was larger and better built, consisting of

four rooms. When tents or temporary houses arrive, the proper location of these should be decided by the sanitary officer in charge. These preliminaries having received attention, the work proper of the sanitary officer begins:

1. The supply of disinfectants should be ordered at once. This order should cover all that will be needed while the emergency lasts, and is necessarily larger in summer than in winter. It was found at Johnstown that the moral effect of a large supply of disinfectants was very great and for good. In ordering disinfectants it is well to provide that what is not needed may be returned to the manufacturers. Pure chemicals and those easy of application are the best.

2. The region should be divided into convenient districts, and each placed under a local physician as sanitary inspector. At Johnstown the local physicians named one of their own number as health officer, and he nominated to the State Board of Health the inspectors, and this plan worked very well. Inspectors are also needed for the camps of citizens and laborers, for the morgues and burial-places. These inspectors should all make a daily report in writing, stating the exact sanitary condition of their districts, and in these reports they should also state any need of food, clothing, shelter, or medical stores. So long as is necessary, the inspectors should give their whole time to their duties.

3. The burial of the dead needs early attention. In summer, this must be hastened if the number be very large; in winter, more time for identification can be given. If the number of dead is very large, and the distress of the survivors too great to permit of accurate identification, bodies should be buried in their clothes, so that identification can be made out at some future time, when the bodies may be lifted for reburial. Very careful and accurate descriptions of the bodies should always be taken before burial. If possible, the bodies should be brought to one point for identification. At Johnstown, for ten days, a large proportion of the bodies were embalmed, but if buried in their clothes this is not necessary. Great care should be taken to number the graves as the bodies were numbered at the morgue, so that when lifted the record may be found to be correct.

4. The water-supply of the district should be inspected at once, and frequently while the emergency continues. Wells and springs had better be closed if any other water is available. Impure drinking-water must not be tolerated for a moment in these emergencies. Chemical analyses should be made frequently.

5. One or more hospitals for contagious diseases should be established at once, and every case of such disease, as it arises, should be transferred to these hospitals, there to remain until all

danger of spreading the disease is over. This is a point of great importance, and its neglect may result in grave disaster.

6. For the convenience of the survivors and of the laborers who may be brought to the place, it will be necessary for the health authorities to see that public privies, or closets, are erected. These should be placed where most convenient. They should be examined by inspectors of the different districts, and should be under the charge of a careful and reliable foreman, who will daily disinfect them. No foul odors should ever be permitted to arise from these places.

7. If the free discharge from the sewers is impeded by *débris*, these should be opened at once, so that water may be discharged through them freely. In the case of floods it will very frequently be found that the mouths of the sewers have been silted shut. These should be opened. The escape of foul gases from sewers at such a time is not to be permitted.

8. There is always, in time of disasters, danger of the people becoming panic-stricken from fear of a pestilence arising, and in our times well-meaning but ignorant persons are very liable to convey messages to the daily press which tend to excite and distress the survivors. To prevent any panic in this way, the State Board of Health found it necessary to issue occasionally "health bulletins," which stated the exact condition of the public health in the devastated district. These bulletins were printed and posted throughout the whole region, and they were thought to do much good. They were founded on the daily reports received from the sanitary inspectors, from the other physicians in the district, and from the hospitals. In addition to these "health bulletins," the people may be greatly aided by issuing "circulars of information." These circulars describe in the plainest language the proper ways to disinfect the premises, to clean them up, and about what should be eaten, and those things which will best tend to preserve health in the midst of unfavorable conditions. These circulars of information should be placed in each house throughout the district as often as may be deemed necessary.

9. It may, in some cases, be desirable to partially or wholly depopulate the devastated district. This may be done by laying out a town of tents, and then requiring the people to remove from their homes into it. Such a town should be laid out as a military camp, and should be under the same regulations as are military camps. At Johnstown, a partial depopulation only was attempted. The State furnished free transportation to all women and children who desired to go elsewhere to their friends for a few weeks or months, and all were urged to go for a short time. For several weeks, also, transportation was given the men who

applied for the same. In this way the population was largely reduced.

10. If the distress of the survivors is very great, it may be necessary for the sanitary officers to assist the inhabitants in the disinfecting and cleansing of their homes. At Johnstown some thirteen hundred cellars were cleansed by the State, and the *débris* was removed from the streets and lots, wherever it was found to contain the bodies of human beings and animals in numbers sufficient to endanger the public health. This work of cleansing the district can only be considered the work of the State so long as the district is in a condition to be denominated a public nuisance. When this ceases, the work of the State must also cease.

11. So soon as the disinfectants arrive, the sanitary officer must see to their proper distribution and instruct the people as to their proper use. At Johnstown, each sanitary inspector in charge of a district was authorized to open one or more depots, in places most convenient for the inhabitants of his district, in which depots disinfectants were stored. Large placards were then printed and posted over each district, telling the inhabitants where they could obtain disinfectants, and urging them to go and obtain supplies of the same. Circulars of information were given to all who applied, as also oral information, explaining how to use each disinfectant. The result was, that people came by the hundreds and carried the disinfectants to their homes, using them with good effect. These stations should be kept open just so long as the district is in a bad sanitary condition. Reference may be made here to the mode of using some of the more common disinfectants. The *débris* formed of the broken houses and forest trees, together with carpets, bedding, and household effects which had become worthless, were, at Johnstown, destroyed by fire, along with the bodies of the domestic animals. For fully three weeks immense fires were burning at Johnstown, formed of the *débris*, and in these fires hundreds of animals were cremated. In the case of a great flood, those articles which it is desirable to burn may be water-soaked, as was the case at Johnstown. Cremation in such cases may be hastened by the addition of petroleum, though at Johnstown a large donation of tar and rosin, made by the citizens of Wilmington, N. C., was used to aid in the combustion of these wet substances. The rosin was found to have very advantageous properties when applied to the cremation of carcasses. It appeared to destroy the unpleasant odors arising from the burning flesh, and in place gave out an agreeable balsamic fragrance. It also burned with great heat, hastening combustion, and could not be extinguished by heavy rains. By using rosin liberally, and adding driftwood, there was no trouble in entirely destroying the domestic animals with a single firing. The

tar was not so valuable in this work as the rosin. Large quantities of quicklime were used at Johnstown, and found to be very valuable for drying the cellars and absorbing unpleasant odors. The people were advised to whitewash their cellars and homes a number of times, as the lime was believed to be very beneficial. Chloride of lime was used also in sprinkling in the cellars and about the houses. The Board of Health also furnished in solution bromine, chloride of lime, carbolic acid, and Quibbells's disinfectant. These were applied by means of sprinkling-cans. So soon also as the streets were cleared of the *débris*, two sprinkling-carts were set running. These used a solution of disinfectants, which had a good effect upon the general atmosphere, and an excellent moral effect, maintaining the confidence of the people. At times, the workmen who are cleaning up the district will imagine that they detect foul odors, and that it is dangerous for them to work without a liberal use of disinfectants. In these cases the presence of a laborer with a sprinkling-can, applying a solution of disinfectants, produces a very reassuring effect. Disinfectants should be freely used about the morgues and in every place where it can be hoped that they will do good. In this connection it may be stated, to the credit of the manufacturers of disinfectants, that, without knowing the means of the Board of Health to pay them, they promptly filled all orders for their supplies without a moment's questioning.

12. That the district may be entirely within the control of the sanitarian, it is important that, as soon as possible, a house-to-house inspection or survey be made of all the houses which are occupied in the district. This survey should be carefully recorded on blanks prepared for the purpose, and should state whether the house is occupied by owner or tenant, the number of rooms, number of families, the adult males, the adult females, and children under five years of age. It should also state the condition of the cellar, kitchen, and living-rooms. The water-supply should be examined and reported upon, as to source, condition, and amount. The drainage of the premises should be carefully looked into. The privy or water-closet should receive a minute inspection. The surveyor should examine the condition of the yard and stable, and the streets and alleys about the house. Note should also be made of any present sickness in the house, and of the existence of any contagious disease in the house during or within six months preceding. If any deaths have occurred within the house in a year, record should be made of them. With all these points before the Board of Health, if the survey has been made with care, it will not be difficult for the Board to maintain good health in the devastated district—certainly not if they have the confidence of the survivors. If the devastated district

is situated upon a stream, as was the case at Johnstown, it will be necessary for the Board of Health to watch that no cause of disaster to regions below is overlooked. It may be necessary to patrol the river below and open drift-piles and burn the carcasses of domestic animals. If the stream is the water-supply for towns or cities below, at the earliest possible moment it must be placed in a condition not to carry disease to such places.

In a word, in a great national disaster, the Board of Health must be prepared to meet each and every emergency as it may arise.

MISSIONS AND MISSION INDIANS OF CALIFORNIA.*

By HENRY W. HENSHAW.

FROM the time of its discovery by Grijalva in 1534 until 1697, a number of fruitless attempts had been made by the Mexican authorities to colonize the peninsula of Lower California, and no small amount of treasure had been wasted in the efforts.

The sole obstacle to the success of the schemes for colonization lay not in the indolent and peaceably disposed Indians, but in the barren and inhospitable nature of the country itself, the wastes of which offered but moderate subsistence to the natives, and nothing whatever to satisfy the love of adventure and the thirst for wealth of the Spaniard. Finding that all attempts to colonize the new country were failures, the Mexican Government turned it over to the Jesuits, who readily undertook its subjection to ecclesiastical authority. The first settlement was made on the Bay of San Dionisio in 1697. The establishment of the missions proper began immediately, and between this period and 1745 no fewer than fourteen were established on the peninsula. It was not until 1769 that the occupancy of Upper California was inaugurated by the founding of the mission of San Diego by the Franciscans, who had superseded the Jesuits in charge of mission work in western Spanish America. From this date until 1823 mission after mission was established to the number of twenty-one, until the entire coast area of California up to and a little beyond the Bay of San Francisco was under mission sway. As mission history forms one of the most interesting chapters relating to the aborigines of this continent, it is the purpose of the present paper to briefly notice the subject, with especial reference to some of the more salient features of mission life and its effect upon the natives.

* The accompanying illustrations are from photographs generously loaned by Mr. S. I. Jannus, who obtained them in 1889.

But, before turning to the subject proper, let us glance at the California Indian as he was found by the missionaries. And first as to his physical appearance.

Vancouver visited San Francisco in 1792, and thus alludes to the natives: "If we except the inhabitants of Tierra del Fuego,

and those of Van Diemen's land, they are certainly a race of the most miserable beings, possessing the faculty of human reason, I ever saw. Their persons, generally speaking, were under the middle size, and very ill made; their faces ugly, presenting a

dull, heavy, and stupid countenance, devoid of sensibility or the least expression."

A few years later, in 1806, Langsdorff describes the same Indians with somewhat more detail, as follows: "These Indians are of a middling, or rather of a low stature, and of a dark-brown color approaching to black. . . . They have large, projecting lips, and broad, flat, negro-like noses; indeed, many of their features, as well as their physiognomy, and almost their color, bear a strong resemblance to the negroes. Their hair is, however, extremely different, being long and straight; if left to grow, it will hang down even to the hips, but they commonly cut it to the length of four or five inches, sticking it out like bristles; this has a very disagreeable appearance in the eyes of a European: the hair grows very far down toward the eyes, so that the forehead is extremely low; the eyebrows are small and the beards thin; many shave them close with mussel-shells. None of the men that we saw were

FIG. 1.—GROUP OF MISSION INDIANS FROM MESA GRANDE, SAN DIEGO COUNTY.

above five feet high; they were ill-proportioned, and had such a dull, heavy, negligent appearance that we all agreed we had never seen a less pleasing specimen of the human race."

The Indians of Santa Clara Mission, many of whom were from the interior tribes, appear to have impressed Langsdorff much more favorably, and he concludes his description of them with the statement that "the people of this mission are,

indeed, generally considered as the handsomest in New California."

The present Indians of San Diego and Los Angeles Counties, a group of whom are presented in Fig. 1, are fair representatives of the mission Indians of southern California. They approach more nearly to Langsdorff's description than to the pen-portrait drawn by Vancouver. It is to be remembered, however, that these Indians belong to the great inland Shoshonian family, and are doubtless intellectually brighter than were their brethren of the coast farther north, about Santa Barbara and San Francisco, who represent distinct families.

I have seen a considerable number of the mission Indians in recent years, and can testify to the general accuracy of Langsdorff's description, though of course they differ much individually and among different tribes. In general it appears to me that the Indians of the interior of the State are less sluggish physically, and are mentally brighter, than those nearer the coast. Taking the coast tribes all in all, they are the lowest type of Indian I have ever seen, and it is probable that they represent the lowest type north of Mexico.

At first this fact seems totally at variance with the fitness of things; for, if California was not literally a land flowing with milk and honey, it possessed every attribute to be desired by a barbarous people. Its climate was mild and equable; its coast and inland waters teemed with fish and mollusks; while the land abounded with game and with nuts, roots, and seeds which were both nutritious and easily procured. With such advantages as these it might be supposed that the natives would have far outstripped the dwellers of less favored sections. Human progress, however, does not always follow the lines of least resistance, and it is probable that in their struggle toward civilization the races of the world owe less to their advantages than to their disadvantages. To put this seeming paradox in other words, man's improvement has been largely compulsory, and, when he is not too heavily handicapped, adverse surroundings stimulate instead of checking his progress. Certain is it that the fine climate and abundant natural products of California had their full effect in developing, or rather in retarding the development, of the natives. Though not deficient physically, the Indians, especially of the warmer portion of the State, were exceedingly indolent and stupid. As a rule they were not hunters but fishers, and hence their blood was not quickened and their muscles hardened by the excitement and toil of the chase; nor were their wits sharpened to the same extent as those of the hunting tribes by the manifold and varied necessities of their calling, nor by the sterner duties of war; for the hunting tribes are invariably warlike. Not so the Califor-

nians; though there was a multiplicity of tribes and an abundant population, and hence ample cause for intertribal strife, their warfare was in keeping with the rest of their character, and had in it little of the aggressive fierceness which characterized other Indians to the eastward. No better evidence of their pusillanimous spirits need be required than their abject submission to mission rule, enforced as it was at each mission by the presence of two or three priests and only a half-dozen armed soldiers.

FIG. 2.—RUINS OF BRANCH MISSION OF PALA, TWENTY-FIVE MILES EAST OF SAN LUIS REY; ESTABLISHED IN 1816.

Though the natives of southern California, as the result of living under rather similar conditions of environment, conformed in a general way in physical appearance and in their mode of life, it must not be supposed that there were not very many distinct tribes which differed in many minor particulars. Within the mission area there were scores, if not hundreds, of tribes—just how many we can not tell—and they were divided among no fewer than nine distinct linguistic families. Perhaps the linguistic differences that characterized these tribes formed the most remarkable point of distinction, and it is doubtful if anywhere else in the world within the same area have there ever been observed so many distinct families of language and so many dialects as in California. As Lamanon remarks, "It is the difficulty of learning all the languages that consoles the missionaries for their not knowing any." In point of fact, the language changed dialectically every ten or fifteen miles, while totally distinct linguistic families succeeded each other in bewildering profusion.

The California tribes were in no sense nomadic. That to some extent they changed their place of abode with the season is doubtless true, and in winter the tribes living immediately on

the more exposed parts of the coast moved inland a greater or less distance.

Although by no means densely populated according to modern ideas, yet California was well divided up among the numerous tribes, and was probably more completely occupied than any other part of the United States. This is attested by the accuracy with which the tribal lands were marked off, in many places by artificial boundaries, as also by the rigidness with which trespass on the territory of neighboring tribes was punished. Population must be large, and the natural products of the soil of considerable value, ere land rights are so carefully guarded. A large population is to be inferred also from the proximity of the missions to each other, since each one required a populous area from which to draw its converts; and, finally, a large population is attested by the mission figures, which show that during the mission period, from 1769 to 1834, some seventy-nine thousand converts were baptized; and yet this number can not by any means have represented the total population for the sixty-five years, since by no means all the Indians were converted.

As the Californian Indians were practically in the same culture state as those of other portions of the United States, though upon a somewhat lower plane, I need not dwell further upon their habits save to say that they lived in conical or wedge-shaped lodges of *tule* or thatched grass, or in temporary wigwams of branches; wore very little clothing; lived largely on fish, mollusks, and seeds, and to a less extent upon game; for the most part made no pottery, but employed soapstone for domestic utensils when that material was available, or used basketry vessels when it was not; were very fond of ornaments; had a complex mythology; resorted to their *shamans* for the cure or prevention of disease, for the destruction of enemies, either personal or tribal, for luck in hunting or fishing; and, finally, were fetich-worshipers. Such were the people to enlighten and Christianize whom was to be the life-work of the Franciscan fathers. Let us now observe the methods adopted for these praiseworthy ends.

The Spanish and Mexican authorities did not intend that the mission reign should be permanent. The viceroys of New Spain saw in California an important political addition to Spanish-Mexican territory, and even when secular colonization failed, and the attempt was abandoned in favor of ecclesiastical methods, the approved plan of the Government for the mission establishments contemplated these as but a temporary means to an end, and full provision was made for the conversion of the missions into secular establishments, quite independent of priestly authority, and for the conferring of citizenship upon the Indians. To this latter end it was provided that after ten years' service in the mission an In-

dian might claim his liberty, provided a respectable settler would become responsible for his good conduct. It was the clearly expressed idea of the Government that the Indians should be rendered self-supporting as rapidly as possible, and the missions were looked upon as educational establishments to this end. Though not openly antagonizing these provisions, the fathers never yielded a hearty assent to the policy, and from the very first sought to render the converts totally dependent and to establish between themselves and their charges the relation of father and children, in which policy they were only too successful. It was no part of their plan to make the Indian self-supporting. The danger of mission disestablishment disturbed the missionaries little, as they openly said the Indians were incapable of self-maintenance.

For its own support and the maintenance of its converts each mission had allotted to it fifteen square miles of land. The buildings were laid out in various ways—sometimes in the form of a square inclosed by a high wall, and sometimes in detached sections. To each mission was allotted a well-built church; and though externally these presented a rather rude appearance, yet their interiors were finished with considerable care, and lavishly decorated as far as the circumstances permitted. Among the pictures that

FIG. 8.—MODERN HUT OF MISSION INDIANS, COAHUILA VALLEY. RAMONA AND CHILDREN IN FOREGROUND.

hung upon the church walls were always to be found two, representing respectively hell and paradise. The former depicted in the most vivid way the future torments of the unregenerate, and it proved a very effective means of conversion.

The houses of the neophytes were usually a little distance from the mission proper, and consisted of open rows of little huts. The accompanying sketch (Fig. 3) affords as good an idea of these

primitive structures as is to be found among the modern mission Indians, and is quite primitive. The roof is composed of thick branches of a kind of sage-brush, and the pole wattles constituting its sides are chinked with mud.

Late in mission history the houses were built of sun-dried bricks, and were reasonably comfortable habitations, but in the early period they were most miserable affairs. Vancouver describes them in 1792, and they were evidently nothing but the native huts, made of willow saplings planted in the earth and brought together at the top, with twigs interwoven and with a thatching of grass and rushes. Vancouver says of them: "These

FIG. 4.—ADOBE HOUSE OF MISSION INDIANS, COAHUILA VALLEY, SAN DIEGO COUNTY.

miserable habitations, each of which was allotted for the residence of a whole family, were erected with some degree of uniformity, about three or four feet asunder, in straight rows, leaving lanes or passages at right angles between them; but these were so abominably infested with every kind of filth and nastiness as to be rendered not less offensive than degrading to the human species."

Fig. 4 shows the modern adobe house, the use of adobe being introduced into California by the Spaniards.

The fact is, that in the aboriginal state the sanitary condition of the Indians was preserved by seasonal changes of residence, or by burning the houses, for one reason or another, chiefly superstitious. They probably never burned them of their own accord

to be rid either of vermin or filth, as the idea of cleanliness for the sake of cleanliness is foreign to the savage mind. Constant residence in one spot, under such conditions as Vancouver and others described, had its legitimate effect upon the health of the neophytes, as we shall see.

In these huts lived the married only; the unmarried were domiciled in separate buildings, usually directly under the eyes of the missionaries, where they were locked up at night, each sex separate. The unmarried women also worked separately, and always under supervision.

When the missions were first established, the good fathers, as a rule, experienced little difficulty in securing converts. Kind words, and the gifts the Indians received in the shape of food and clothing, proved an efficient means of conversion, and they were baptized in gratifying numbers. Converts were encouraged to visit their wild brethren at home, and by flattering accounts of mission life induced many to return with them. As neophytes grew scarce, the area from which they were drawn was extended, and a greater or less number of recruits was obtained from the distant interior tribes. Later, such means proved unavailing, and other and more questionable methods were resorted to. Upon one pretext or another, armed soldiers and armed converts were sent out who frequently returned with a goodly number of captives; and, for two reasons, these were mostly women and children: first, because they were preferred, since the husbands frequently followed them into captivity; and, secondly, because in the conflicts which preceded the capture of the wives and children many of the men were killed and the rest driven away. In these conflicts the wounded appear to have received little mercy. Beechey witnessed the tragical issue of one of these holiday excursions by the neophytes of the mission of San José, and we are indebted to him for the details. An armed launch had been placed in charge of an alcalde of the mission, who while on the trip planned an attack upon the Cosemenes of the San Joaquin, either directly for the purpose of securing converts or in revenge for some aggression. While in camp near the village they intended to attack, the neophyte party was surprised by the Cosemenes, and thirty-four were killed or taken captive. In this case apparently the alcalde acted without authority, and doubtless without knowledge or connivance on the part of the priests. However, when the news reached the mission it was thought necessary to strike terror into the victorious tribe, and accordingly an expedition was sent against them. The result was that forty men, women, and children were killed and forty women and children were captured and brought back to the mission. Thus the loss of the converts was more than made good, the surrounding tribes were in-

spired with terror, and all with the loss of one Christian, who was killed by the bursting of his own gun. Such acts reveal the darker side of mission history, and the attempt has been often made to free the priests from the blame of such transactions, on the ground that they were ignorant of the extreme means employed. Such

FIG. 5.—COAHUILA INDIAN, FORMERLY A NEOPHYTE OF SAN GABRIEL MISSION, LOS ANGELES COUNTY.

can hardly have been the case. Even when the ostensible purpose of the visits of the converts was peace and not war, they were armed, the boat being often provided, as Beechey tells us, with cannon and musketry. Under such circumstances of superiority it would have needed no prophet to foretell the probable action

of Indian neophytes, doubtless often with old grudges to pay off and eager to find favor in the eyes of their masters, and to claim the reward of their zeal in the new faith. Another fruitful occasion for wholesale capture was the escape of converts to neighboring tribes, and the attempt to recapture them by armed force, to which are to be added, of course, the petty manifestations of hostility on the part of the unconverted tribes. Overt acts on their part were followed by reprisals, and these always meant a fresh supply of converts.

Having gained possession of their subjects, the next step was to convert them to Christianity—a process neither very long nor tedious. Before baptism it was customary to prepare the candidates—if the term be applicable to unwilling captives—by preliminary instruction, which the padres state never occupied less than eight days. How clear an insight into the mysteries of the Christian religion a pagan Indian, fresh from the worship of his fetiches, is likely to obtain in eight days may be imagined; but the fathers declared that the instruction was ample. The usual method of enlightenment is thus detailed by Beechey:

"Immediately the Indians are brought to the mission they are placed under the tuition of some of the most enlightened of their countrymen, who teach them to repeat in Spanish the Lord's Prayer and certain passages in the Romish litany; and also to cross themselves properly on entering the church. In a few days a willing Indian becomes a proficient in these mysteries, and suffers himself to be baptized and duly initiated into the church. If, however, as it not unfrequently happens, any of the captured Indians show a repugnance to conversion, it is the practice to imprison them for a few days, and then to allow them to breathe a little fresh air in a walk round the mission to observe the happy mode of life of their converted countrymen; after which they are again shut up, and thus continue to be incarcerated until they declare their readiness to renounce the religion of their forefathers." A remark by Beechey that he thought the teachers had an arduous task, elicited from the priest the reply that "they had never found any difficulty; that the Indians were accustomed to change their own gods, and that their conversion was in a manner habitual to them." This was undoubtedly true, as was evidenced by the rapidity with which numbers apostatized in favor of their earlier gods whenever occasion offered.

Discipline among the converts was administered with some severity. As was to be expected, desertion and the non-performance of their religious duties were the chief occasions of punishment. A church-service is thus described by Beechey (page 367):

"After the bell had done tolling, several *alguazils* went round to the huts to see if all the Indians were at church; and if they

FIG. 6.—CAHUILLA MISSION INDIAN GRINDING SEEDS. INDIAN POTTERY, BASKETS, SEED-BEATERS, ETC.

found any loitering within them, they exercised with tolerable freedom a long lash, with a broad thong at the end of it—a discipline which appeared the more tyrannical, as the church was not sufficiently capacious for all the attendants, and several sat upon the steps without.

"The congregation was arranged on both sides of the building, separated by a wide aisle passing along the center, in which were stationed several *alguazils* with whips, canes, and goads to preserve silence and maintain order; and, what seemed more difficult than either, to keep the congregation in their kneeling posture. The goads were better adapted to this purpose than the whips, as they would reach a long way, and inflict a sharp puncture without making any noise. The end of the church was occupied by a guard of soldiers under arms, with fixed bayonets—a precaution which I suppose experience had taught the necessity of observing." The spectacle presented of church doors guarded by soldiers, and of attendants provided with whips and goads to prick the unwilling or ignorant into kneeling, is certainly not a very edifying spectacle according to later ideas, and savors far too much of slavery. Indeed, the resemblance was suggested to more than one eye-witness; and Pérouse finds in the system an unhappy resemblance to the slave plantations of Santo Domingo. He says: "With pain we say it, the resemblance is so perfect that we have seen men and women in irons or in the stocks; and even the sound of the lash might have struck our ears, that punishment being also admitted, though practiced with little severity."

It is not improbable that there were occasional instances in which undue severity was exercised in punishment, but it is safe to conclude that cases of actual cruelty were not common. When such occurred, it is probable that they were the acts of the subordinate officers of the missions, who were chiefly Indians, and that they were not sanctioned by the priests. Nevertheless, the charge was more than once made by the Government authorities. Offenders were punished by fetters, the whip, and the stocks, and by imprisonment. Estudillo says that the friars treated the neophytes as their children, correcting them with words, and for serious offenses with from twelve to twenty-five lashes. Subsequently the latter number was the extreme limit fixed by authority, the implication being that occasionally at least this number had been exceeded. A deserter, says Langsdorff, was bastinadoed, and an iron rod a foot or a foot and a half long was fastened to one of his feet.

From the very first the fathers adopted the policy of compelling the neophytes to work. By this means not only were they instructed in certain useful occupations and kept out of mischief, but by the products of their labor the missions were largely sup-

ported and a considerable revenue derived from the sale of such products to the *presidios*. All the agricultural and manufacturing work was performed by the Indians. Each mission had a large flock of sheep, the eleven missions in 1800 possessing eighty-six thousand. The Indians sheared the wool, and spun and wove it into blankets and coarse fabrics for clothing. They also made

FIG 7.—ABORIGINAL GRANARIES MADE OF WILLOW.

soap, and tanned the skins and hides; they were the shoemakers and saddlers, the carpenters and blacksmiths.

With respect to the number of hours the neophytes were compelled to labor, there seems to be some doubt. In reply to the commandant's charge that the neophytes were compelled to work from six to nine hours a day, with extra work on special occasions

as in harvest-time, and that the tasks laid upon both women and men were too heavy, the fathers asserted that the working hours were only from four to six hours, and that tasks were light, since not more than one half the neophytes worked at any one time, being excused on one pretext or another; and that even when they did work they never worked hard. Those familiar with the Indians will be likely to accept the statements of the missionaries, since to induce the average Indian, half or wholly wild, to overwork himself in steady toil would require a much more severe *régime* than there is any evidence was ever employed at the missions.

Pérouse has left us an account of a day's routine at one of the missions, and, as the methods varied but little at the several establishments, it will probably answer for all: "The Indians, as well as the missionaries, rise with the sun and go to mass, which lasts about an hour. While this is in progress the breakfast is prepared, the favorite *atole* or pottage, which consists of barley-flour, the grain being roasted previously to grinding. It is cooked in large kettles, and is seasoned with neither salt nor butter. Every cottage or hut sends for the allowance for all its inmates, which is carried home in one of their large baskets. Any overplus that remains is distributed among the children as a reward for good behavior, particularly for good lessons in the catechism. After breakfast, which lasts about three quarters of an hour, they pro-

FIG. 8.—MISSION INDIAN GRAVEYARD IN COAHUILA VALLEY, SAN DIEGO COUNTY.

ceed to their labors, either out of doors or within. At noon the dinner is announced by a bell, and the Indians quitting their work go and receive their rations as at breakfast-time. The mess now served is somewhat of the same kind as the former, only varied by the addition of maize, peas, and beans; it is named *pozzoli*. After dinner they return to their work, from two to four or five; afterward they attend evening mass, which lasts nearly an hour, and the day is finished by another supply of *atole*, as at breakfast.

In the intervals of the meals and prayers the Indians are of course variously employed according to their trade or occupation—that is to say, either in agricultural labors, according to the season, or in the store-rooms, magazines, and laboratories of the mission. The women are much occupied in spinning and other little household labors, the men in combing wool, weaving, melting tallow, etc. One of the principal occupations of the missions is the manufacturing a coarse sort of cloth from the wool of their own sheep for the purpose of clothing the Indians. The grinding the corn is left almost entirely to the women, and is still performed by a hand-mill."

It was a shrewd stroke of policy on the part of the fathers to allot the laborious work of grinding meal to the women, in whose hands it had been from time immemorial, since the men would have stooped to such labor only by dint of the strongest coercion.

FIG. 9.—MODERN MISSION INDIAN ON HIS TRAVELS.

With reference to the grinding of corn, Langsdorff (1806), learning that the hand-mill which Pérouse, out of the kindness of his heart, left at the San Carlos Mission (1786), with the view to lighten the heavy labor of the mealing-stones, was not in existence, and that no use had been made of it as a model to manufacture others, records the curious fact that in perpetuating the use of the stone grinding process the fathers were actuated by motives of policy. To use his own words, "As they have more men

and women under their care than they could keep constantly employed the whole year, if labor were too much facilitated, they are afraid of making them idle by the introduction of mills." With the fathers the important question was, not how many converts can be well instructed, and by what method can their progress to civilization be best facilitated, but how many can be got together to be baptized and saved from the devil. Not improvement but conversion was their guiding motive.

There is no good reason to believe that the neophytes were not well fed, though the contrary was asserted by officials inimical to the mission policy. That their fare lacked variety is probable, but there was enough of it, and it was served three times a day, as Beechey tells us, adding that it consisted of "thick gruel made of wheat, Indian corn, and sometimes acorns, to which at noon is generally added meat."

That the rule at the missions was not all work and no play is evidenced by the fact that the neophytes were allowed to indulge in their own habits and customs so far, says Langsdorff, as "they are not inconsistent with their new religion. In their dances, their amusements, their sports, their ornaments, they are freely indulged." Like other Indians, they were great gamblers; and, whether by the tacit permission of the priests or not, they indulged freely in the passion, chiefly by means of games of their own invention. Drunkenness was more or less common among them.

The picture of the California neophyte under mission rule thus presented, while having its dark side, is by no means a revolting one, and at first sight it might be supposed that the Indians under such a system should be better off and happier than in their original condition. They were well fed, well clothed, if not well housed; their tasks were not heavy, a reasonable amount of amusement was allowed, and they needed to take no thought for the morrow, for everything was provided. While it must be evident at once that such a system could not but prove an absolute failure as regards the true civilization of the Indian, it does not immediately appear why he should not have been contented with his lot. If he was not contented, the fault lay with the system or the Indian, and certainly not with the personal character of the priests; for, while there were a few black sheep among them, as a body they represented a high standard of benevolence and integrity. All who visited the missions in the early days extol the fathers for the unselfish spirit with which they devoted themselves to what they believed to be the welfare of their subjects and their kind-heartedness. It is doubtful if a purer and more devoted set of men ever labored for the good of the heathen than the early missionaries of California. Having power the most

absolute, in the main they wielded it with moderation if not always with discretion; and, if they placed the spiritual welfare of their children above their earthly good, it was due to the times and their calling. It may be added that the same error is too often to be discerned in missionary systems the world over. In order to Christianize, the missionary should first educate.

The best proof of the good character and kindness of the fathers is to be found in the fact that many of the neophytes cherished an unbounded affection for them, as is attested by many contemporaries. Nevertheless, from first to last of mission rule, discontent was rife among the converts, and had the mission Indian possessed but a spark of the courage which characterizes our Eastern tribes, mission sway would have been short-lived. Imagine a body of Iroquois driven to church by the whip, or forced to kneel by being punched with goads! The evidences of discontent appear in the threatened uprising at all the missions and the actual revolts at several, by the hostile attitude of all the gentile tribes who were brought into direct or indirect relation with the missions; and, above all, by the numerous yearly desertions at every establishment. The causes of trouble are not far to seek. In the first place it is evident that, call it by what name you will, the neophytes were subjected to a state of slavery—a slavery, too, which galled, however mild the type, but from which they found it exceedingly difficult to escape; for, in addition to the aid of the soldiers in hunting renegades, the priests could usually count upon the assistance of the gentile tribes to return fugitives. The wild Indians hated the neophytes, and the rule among them was—once a neophyte always a neophyte. How strongly linked was the chain which bound the neophyte appears in the provision that, even when liberty was given him after ten years' service, a portion of his earnings was still claimed by the Church. The crops the neophytes were compelled to sow were sown mainly for the profit of others, the harvests they reaped were not their own. Thus the usual incentives of toil were absent. Though professedly regarded as a child by the fathers, the Indian was virtually a slave.

The sudden breaking up of all tribal ties and the substitution of arbitrary authority for the independence of the liberty-loving Indian, together with the complete change of life, must also have been irksome and productive of unhappiness.

Possibly, however, the most potent of all causes for discontent is to be ascribed to the fearful mortality which from the very first raged among the mission folds. Its sources are somewhat obscure, although it is safe to attribute it largely to what may be termed unnatural conditions of life. It is stated, and it may be readily believed, that when visited by even trifling disorders the

Indian became despondent, generally refused to be ministered to, and often died without apparent adequate cause. The Indian rarely has much faith in civilized medical methods, and when really sick almost invariably prefers the ministrations of his own *shaman*. Moreover, in the case of the California Indians there is reason to believe that their want of faith in the skill of the padres was well founded; for both Beechey and Langsdorff, differing from Vancouver, note the astonishing amount of sickness among the converts, and comment upon the lack of medicines and the ignorance of the fathers as medical advisers.

Acknowledgments are due to Hubert H. Bancroft, not only for a mass of hitherto unpublished facts relating to mission history, but for many statistics of baptisms, births, deaths, etc., which he has culled from mission archives. These are given by decades for every mission. From these it appears that during the mission period, from 1769 to 1834, an interval of sixty-five years, seventy-nine thousand converts were baptized and sixty-two thousand deaths were recorded. An analysis of the statistics furnished by Bancroft reveals the fact that the death-rate among the neophytes was about twice that of the negro in this country, and no less than four times as great as the death-rate of the white population.

At no time would it appear that the number of the births among the mission converts was equal to the deaths. According to Bandine, the governor states, in a report for 1800, that the number of deaths is almost double that of births; and again, in 1815, the president of the missions stated that there were three deaths to two births. It was only by perpetual drafts upon the surrounding tribes that the missions were sustained at all. The high death-rate and small birth-rate explain what has become of the California mission Indian. The former can not be attributed to ordinary diseases, even when is taken into account the despondency of the Indians when sick and the lack of proper medical treatment. The records show that epidemics of small-pox, measles, pulmonary diseases, and intermittent fever prevailed at several periods, and all observers testify to the early introduction of syphilis among the natives and to its severe ravages. With this knowledge, perhaps it is not necessary to inquire further. When are taken into consideration the unnatural herding together of large numbers of Indians under the most unsanitary conditions, practically without medicines and without proper medical attendance, the ordinary effect of disease being heightened by the dejection of the patients, and then add an epidemic or two of any of the above diseases, and the probable result may easily be foretold. The wonder is, not that the Indians died off rapidly, but that any of them survived.

How many of them actually did survive can not be told, but the number was relatively very small. The decree for the disestablishment of the missions was made by the Spanish Cortes in 1813, but it was not carried into final effect until 1834. Between 1820 and 1830 there was a gradual but marked decline in mission prosperity. In 1834 the twenty-one missions contained fifteen thousand converts; but earlier than this the constant drafts upon the native tribes had about exhausted the supply, and by 1830 no more converts were to be had within reach of most of the missions. In fact, most of the natives had been converted out of existence.

The wealth of the missions was no mean dowry for the surviving neophytes, for collectively they now contained among other property one hundred and forty thousand cattle, twelve thousand horses, and one hundred and thirty thousand sheep; which totals, though reduced from previous years, will afford some idea of the wealth resulting from convert labor and missionary overseeing. The missions had been more successful in the accumulation of property than in civilizing the Indians.

As has been stated, the original plan of colonization contemplated the Indian as a citizen in individual possession of land, each with his share of the accumulated mission property, consisting of horses, cattle, sheep, etc. The experiment of giving the Indian his freedom, so long contemplated, was now (1834) to be tried. The fathers, facing the inevitable, recommended that a partial trial be made first, as they believed that the Indian was not ready for the experiment; and, indeed, how was it possible that he should be? Had the intention from the very first been to unfit him for independent existence, no better plan could have been devised than the one actually followed. Educated he was not, except in the necessary portions of the ritual of the Catholic Church, and in so far as a certain number spoke Spanish. Civilized he certainly was not, since his knowledge of the art of husbandry and of the manual arts was only sufficient to enable him to be a producer under task-masters. He was, in fact, master scarcely of the rudiments of civilization. In short, at the end of mission rule, the Indian was really less capable of taking care of himself than at the beginning: he was found a free man—he was left a dependent.

Could the provisions of the secularization act have been carried out gradually and honestly by capable officers and with the co-operation of the missionaries, even then it may be doubted if the intelligence and civilized attainments of the Indian would have been equal to the occasion. As it was, political considerations prevented a fair trial of the plan, and the final act in the mission drama is little else but a history of robbery and oppres-

sion, in which the Indian, as usual, was the sufferer. The vast mission herds and flocks melted away; the implements which were intended for the use of the Indian farmers were not, as a rule, forthcoming; and, of course, without domestic animals and without the means of tillage, the land was of no use. The Government, though possessing no claims whatever upon the mission property, made frequent demands upon it, and, as Bancroft states, the period from 1836 to 1842 was one of disaster in mission history. The downward path of the natives was rapid. Those who obtained property sold it and converted the proceeds into liquor and then resorted to stealing, to flight to the wild tribes, or to return to bondage under the guise of servants in the town or on the ranches. In the area between the Bay of San Francisco and Los Angeles there are to-day probably not one hundred Indians. Of the so-called mission Indians in San Bernardino and Los Angeles Counties, the last Indian report gives a population of four thousand three hundred and thirty. But very few of these are descendants of the mission Indians of Franciscan times.

Such, in brief outline, is the history of the mission Indians. They lived and died, and their few descendants now drag on a miserable existence in out-of-the-way places, so poor and barren as to be beyond the covetousness of the whites, or live dependent wards of the Government.

MENTAL STRAIN.

By M. CHARLES RICHET.

A BOOK on mental over-pressure has been written by Madame Manacéine for the protection of the men who are to follow us. A continuance of the kind of life that is now led in the great centers of civilization will involve the risk of compromising the lot of future generations. We are going blindly, groping, toward a new humanity, to issue from us, of which we can not predict the character. This humanity is in danger of being a poor affair indeed, from whatever point of view we may regard the case, unless we conduct ourselves better. Madame Manacéine has undertaken to analyze the present conditions of existence, physiological and psychological; to exhibit us to ourselves as we are; to draw a balance-sheet of our mistakes in habits and education, for the avoidance of a threatened decay. We owe her thanks for her generous and patient attempt.

We have no right to be unconcerned about the future of mankind. We have an account to settle with the men of coming ages. We must be careful for them. They are worthy of our interest

and forethought, and we should be very culpable if we did not have some care for the fate of our great-great-grandchildren.

The prominent characteristic of living beings, of whatever kind, is the tendency to resemble their parents. It is fatal, irresistible, and dominant in all biological laws. By heredity we acquire this or that trait of our fathers, whether it be natural or acquired in them. The consequence of this fact is momentous, and has been admirably set forth by M. Marion in his book on Moral Solidarity. It is, that our children will be the same as we have been. They are our image and the faithful portrait of ourselves. A vice acquired by us will become natural with them. An accidental physical or moral blemish, brought on by our faults, or errors, or carelessness, will become in them a natural blemish, and they will transmit it to their descendants.

Unless we are now able to preserve our mental and bodily forces intact, our grandchildren will be victims to our faults. They would even have the right to a certain extent to call us to account for our careless conduct. "What did you do with that vigorous body and healthy and sturdy mind that were given you by your parents? for it is by your fault that we are miserable and sickly." The importance of the question is thus well established. Since the future depends on the present, it is no less than a question of the future of men. This being fixed, the query arises, Is there mental overstrain? A careful examination of the facts gives us occasion to answer affirmatively. In consequence of the prodigiously artificial conditions of existence which our advanced civilization has imposed upon us, we have greatly modified the habitual and physiological life of our organism. A close study of the habits of contemporary men, such as the author of this book has made, will show that nothing is less in agreement with a healthy vitality than the mode of living of to-day.

From very early years children are shut up in work-rooms for many hours with tiresome books. They have no sufficient distraction from these books, no better prospect of good to be derived from them than the hope of some time passing an examination, complicated, hard, and encyclopedic, of a compass surpassing that of the knowledge of the wisest man that can be imagined. Then, in youth there are still examinations, still hours of study, still books, with only the scantiest provisions for diversion and recreation, except by resorting to fatiguing dissipations. Too much civilization, too much mental culture, with too little care for the physical part. Do we forget that the material structure is the organ of the mind, and that the mind can not maintain itself in an enfeebled body? We ought to realize that sooner or later the body will avenge itself. We can not break away with impunity from the laws of sound psychological hygiene. The

muscle that is not exercised becomes atrophied; the muscle that works too much becomes diseased. The mind that is not exercised decays; the mind that labors too much is distorted, and we reach the sad result of weakening the understanding by the excess of labor to which we subject it, of destroying the instrument we use.

The philosophers of the eighteenth century extolled what they vaguely called a return to the state of nature. They imagined that man was primarily a perfect being, and that, as his intellectual and social growth have gone on, he has correspondingly degenerated and become vicious. Nature did well, they said, but civilization made him wicked. The reverse of this, however, is nearer the truth; and if we had to look for types of moral perfection, we should not go among savage peoples. Neither do savages excel the civilized races in vigor and health of body. But while we recognize that savages are not men whose bodies and minds are in a supreme condition of excellence, we have to acknowledge that civilized man has singularly neglected his body, that vesture to which it is necessary to attach some importance; for, without that vesture, there is no man.

It is indeed hard to maintain the equilibrium of body and mind. If we should try to lead an exclusively animal life, devoted to eating, walking, sleeping, and making love, we should find such existence insipid enough. We could not maintain it if we would, for there are a thousand features of our present life that we could not eliminate. But we can and should recommend and require that a considerable place be given to physical exercise. English youth, who practice passionately at cricket, cycling, and canoeing, are at the same time good Hellenists, and often excellent mathematicians. It is all the better for the mind to work, on condition that the body is also exercised. A sound mind in a sound body was the ancient maxim of the school of Salerno, and no better formula has yet been found. Let us, then, have some regard for the well-being of the body. Let us learn to keep our muscles in full energy, to breathe the fresh and bracing air of the mountains and the sea; or, if these are too far away, the air of the fields around our towns. By brief distractions of this kind we will benefit the mind.

The sad thing about the matter is, that it is not so much intellectual labor, of which the mind is capable of doing a great deal, as irregularities in that labor, that do the harm. We are satisfied that the great workers, who have performed grand achievements by genius or patience, owe their triumph less to a temporary excess of labor, than to continuous, regular, persevering work,*

* Littré, one of the greatest workers that ever were, passed his whole day out of doors, and never began to work till evening, at half-past seven, after dinner, and then stayed in his library, bent over his books, without any relief, till about four o'clock in the morning.

[illegible] truths. [illegible] shall [illegible] animals, and consequently [illegible] care of the animal which is half and perhaps a little more than half of ourselves. If the animal suffers, the angel [illegible]. The future is for the races that do not sacrifice their [illegible]

From Label for the Popular Science Monthly from the Re[illegible]

[illegible] Charles came home with M. Barthelemy Saint-Hilaire, he sometimes, when about [illegible] to work, for M. Barthelemy-Saint-Hilaire was accustomed to [illegible] M. Littré led this laborious life, with inexorable regularity, for more [illegible]

ANCIENT AND MODERN IDEAS OF HELL.

By FREDERIK A. FERNALD.

THE idea of a place for the punishment after death of wicked men is found in most, though not all, of the religions of the present time and of antiquity. According to some beliefs, the punishment is to last forever; according to others, the torments are to continue only for a time, and are to result in purifying the imprisoned souls and fitting them for heaven. The Roman Catholic religion has both a purgatory, or place of temporary torment, and a hell, which is everlasting. No idea of penalty was connected with the classic hades—it was simply an under-world where dwelt all those who had the misfortune to be dead, irrespective of their conduct in life. The word comes from the Greek adjective Ἀΐδης, meaning *unseen*. The English word hell had also originally the same meaning. It is derived from the Teutonic base *hal*, whence also the Anglo-Saxon *helan*, to hide, "so that the original sense is the hidden or unseen place" (Skeat).

The conception of future existence which lays claim to the greatest antiquity is that of the ancient Egyptians. According to the Egyptian belief, if the great judgment resulted adversely, "the condemned soul is either scourged back to the earth straightway, to live again in the form of a vile animal, as some of the emblems appear to denote; or plunged into the tortures of a horrid hell of fire and devils below, as numerous engravings set forth; or driven into the atmosphere, to be vexed and tossed by tempests, violently whirled in blasts and clouds, till its sins are expiated, and another probation granted through a renewed existence in human form." * In his description of the Ritual of the Dead, Renouf † mentions chapters in that book intended to secure the soul against dangers in the nether world, such as having his head cut off, dying the second death, suffering corruption, being turned away from his house, going to the *nemmat* (an infernal block for the execution of the wicked), going headlong into the *cherti-nutar*, and eating or drinking filth. Various divinities are invoked to save the soul from that god who feeds upon the accursed, from that god who seizes upon souls, devours hearts, and feeds upon carcasses. These perils which the good escape, says Renouf, sufficiently show the fate which the wicked must expect.

From Persia, also, we get a religion of great antiquity—Zoroastrianism—which, in a modified form, is held to-day by the small

* William R. Alger, A Critical History of the Doctrine of a Future Life, tenth edition, 1878, p. 103.

† The Religion of Ancient Egypt.

body of Parsis still to be found in Persia and India. According to the Parsi belief, the good after death pass safely over the bridge Chinevat, which stretches from Mount Alborj up to Garotman, the blissful realm of Ormuzd; while the wicked fall from the bridge into the Gulf of Duzahk, which yawns beneath, where they are tormented by dævas. At the end of the world, a comet will fall upon the earth, causing a vast conflagration, by which the whole earth will be melted, and the molten stream will pour down into Duzahk, carrying with it the sinners who are on earth at the time. Here they and the earlier comers, except those already redeemed by the prayers of friends, will burn for three days and nights and then thus purified will be received into heaven. Afterward all the dævas, and even the arch-fiend Ahriman, will have their evil burned away and will also enter the abode of light.

The Laws of Manu, one of the early sacred books of Brahmanism, names twenty-one hells. Punishments for different sins are, to be reborn into one of these hells, or to return to earth as a beggar, cripple, or leper, or in the form of a rat, a snake, or a louse, the penalty being in each case appropriate to the crime. Punishment need not be endless for any one, as each successive life is a new probation, in which righteousness wins admission to a higher stage of existence.

In Buddhism, which is one of the religions of China, and the state religion of Thibet and other countries of eastern Asia, future punishment is provided for in a great hell, comprising a system of one hundred and thirty-six lesser hells. The torments of these hells are depicted in many Buddhist books and paintings, with much detail and vividness.

The punishments recorded in the Jade Record and other works on future torment give frightful pictures of the torture of bad men; in many Buddhist temples these are represented by small figures, and in others by life-size images. Men are ground to powder, the dust becoming ants, fleas, and lice; pestled in a mortar, and mashed to jelly in iron mortars; chopped in slices with a knife and hacked to pieces with hatchets; the tongue of deceit and lying pulled out; sawn asunder; the bones and flesh crushed by falling mountains; women cast into a lake of blood; crossing the narrow bridge and falling among fiery serpents; the caldron of oil for those who waste rice; drunkards with the cangue and standing on the hands; quack doctors with hands and feet tied, and a large stone on the back, the fierce judge administering hot drinks; a man going into the mill head foremost, with the legs sticking out, and a dog coming out below in the transmigration; a headless ghost pulling his murderer to judgment; disemboweled, tossed on a hill of knives; cast on a lake of ice; chained to a red-hot cylinder; iron dungeon, darkness within and fire without; lashed with burning iron wires; when thirsty, drinking molten iron; eating red-hot iron balls; besides, there is the freezing hell, the burning hell, and the hell of bubbling filth.*

* The Dragon, Image, and Demon, by the Rev. Hampden C. Du Bose, pp. 311–313.

As for the two other religions of China, Confucianism tells nothing whatever about punishment after this life, while Taouism has a theory of retribution much like that of Brahmanism.

The Jews in Old Testament times had no idea of a hell. There is no mention of punishment after death in the teachings of Moses, nor is this doctrine taught by the prophets. The word *sheol*, which is translated by hell in the King James version of the Bible, meant simply the abode of the dead, and corresponded to the Greek *hades*, used in the New Testament and other Greek writings. Gloomy and repulsive ideas were associated with sheol, similar to those we connect with death and the grave, but it was the destination of good and bad alike, and not a place of punishment.* The troubles which the wicked and the enemies of the Jews were threatened with by the prophets pertained to this world. They were pain, disease, loss of possessions and kindred, hostility of neighbors, death, and indignities to the dead body. The idea of sheol first became modified after the Persian captivity. The place was divided into two parts, which were separated only by the width of a thread. One of these divisions was for the good, awaiting resurrection, and was called Paradise; the other, set apart for the wicked, was called Gehenna. This latter designation means "the valley of the son of Hinnom," and was originally the name of a gorge outside of Jerusalem in which the Jews had practiced the fiery worship of Moloch, and where afterward offal from the city and the bodies of criminals were thrown, to be consumed by the fires always kept burning there. The idea of Gehenna as a place of future punishment had appeared in rabbinical theology and become quite detailed a century or more before Christ. Hell was represented as having special apartments for different kinds of torment. One place, from its darkness, was called "Night of Horrors." The fire of Gehenna was said to have been kindled on the evening of the first Sabbath, and would never be extinguished.† A Talmudic writer, quoted by Alger,‡ says: "There are in hell seven abodes, in each abode seven thousand caverns, in each cavern seven thousand clefts, in each cleft seven thousand scorpions; each scorpion has seven limbs, and on each limb are seven thousand barrels of gall. There are also in hell seven rivers of rankest poison, so deadly that if one touches it he bursts."

At the coming of Christ, there were three chief sects among the Jews. The Pharisees, who were by far the most numerous, believed that sinners were kept forever in a prison in the underworld; the Essenes believed that the vicious suffered eternal pun-

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* Schaff-Herzog, Encyclopædia of Religious Knowledge, article Hell.

‡ Basnage, History of the Jews, lib. iv, cap. 30. † Future Life, p. 509.

ishment in a dark, cold place; and the Sadducees thought that the soul died with the body. The first threats of hell in the Scriptures occur in the teachings of Jesus. There are three words in the New Testament which were translated by hell in the King James Bible: *hades*, meaning the same as elsewhere in Greek literature; *Gehenna*, which was properly the hell of Hebrew conception, and is uniformly so rendered in the revised version; and *Tartarus*, used only once (2 Peter, iii, 4), which is the regular Greek word for the place of punishment after death.* The place of future punishment represented in Christ's teachings is a region of fire: "Whosoever shall say, Thou fool, shall be in danger of the hell of fire" (Matt. v, 22, revised version); the fire is to be eternal and unquenchable: "It is good for thee to enter into life maimed, rather than having thy two hands to go into hell, into the unquenchable fire, . . . where their worm dieth not, and the fire is not quenched" (Mark ix, 43, 48; see also Matt. xviii, 8). In Revelation" St. John informs us what fuel is to support the unquenchable fire: "If any man worshipeth the beast and his image, . . . he shall be tormented with fire and brimstone in the presence of the holy angels, and in the presence of the Lamb: and the smoke of their torment goeth up forever and ever; and they have no rest day and night" (Rev. xiv, 9–11). In another passage it is revealed concerning various kinds of sinners that "their part shall be in the lake that burneth with fire and brimstone: which is the second death" (Rev. xxi, 8). This doctrine was intended to last unchanged for all time, for we find in the last chapter the statement that, if any man shall add to or take from the words of this book, he shall suffer all the torments and lose all the rewards which are written in this prophecy (Rev. xxii, 18, 19).

The religion of Islam is characterized by lack of originality, and the Mohammedan hell contains nothing but easily made variations of the Gehenna of the Jews. To the man that disobeys the precepts of the Koran it is promised that "God shall cast him into hell-fire; he shall remain therein forever."† Further it is written: "Verily, those who disbelieve our signs, we will surely cast to be broiled in hell-fire; so often as their skins shall be well burned, we will give them other skins in exchange, that they may taste the sharper torment, for God is mighty and wise" (chapter iv). The physical pain of fire, applied in various ways, is also the staple of the following torments: "They who believe not shall have garments of fire fitted to them; boiling water shall be poured on their heads; their bowels shall be dissolved thereby, and also their skins; and they shall be beaten with maces of iron" (chap-

* Schaff-Herzog, ibid., idem. † The Koran, Sale's translation, chapter iv.

ter xxii). Those men who are sent to the left hand on the judgment-day "shall dwell amid burning winds and scalding water, under the shade of a black smoke, neither cool nor agreeable." Ye "shall surely eat of the fruit of the tree of *al-Zakkum*,* and shall fill your bellies therewith; and ye shall drink there only boiling water."

In the Greek mythology, which was copied by the Romans, the place of future punishment is called Tartarus. The universe is represented in the poetry of Homer and Hesiod as a hollow globe, divided by the flat earth. In the top of the upper hemisphere was Olympus, the home of the gods; in the hemisphere beneath the earth was hades, the abode of all the dead; and in its lowest depths was Tartarus. An anvil would be nine days and nights in falling from Olympus to the earth; nine days and nights from the earth to the bottom of Tartarus. "Around it, moreover, a brazen fence has been forged; and about it Night is poured in three rows." † In Tartarus there is darkness, and the air has no motion. It was at this time regarded as the place of punishment for the Titans, who had rebelled against the powers of Olympus. Later the poets began to speak of mortals who had offended the gods, or had been unjust to their fellow-men, being sent there after death. Prometheus, who was guilty of overreaching Zeus, was punished by being chained to a rock, part of the time on earth and part in Tartarus. An eagle devoured his liver every day, and it was renewed every night.‡ Ixion, who had been treacherous to Zeus, was chained by the hands and feet to a wheel, which is described as winged or fiery, and said to have rolled perpetually in the air. He is further said to have been scourged and compelled to exclaim, "Benefactors should be honored." ‡

Sisyphus is represented by different authors as guilty of treachery of various kinds. "His wickedness during life was severely punished in the lower world, where he had to roll up hill a huge marble block, which, as soon as it reached the top, always rolled down again." ‡ Tantalus was a wealthy king, who divulged the secrets of Zeus. "The gods punished him by placing him in the nether world in the midst of a lake, but rendering it impossible for him to drink when he was thirsty, the water always withdrawing when he stooped. Branches laden with fruit, moreover, hung over his head, but when he stretched out his hand to reach the fruit the branches withdrew. Over his head there was suspended a huge rock, ever threatening to crush him." ‡ The Danaides, or fifty daughters of Danaus, all but one of whom in

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* A thorny tree with a fruit like an almond, but extremely bitter (Sale).

† Hesiod, Theogony.

‡ Smith, Dictionary of Greek and Roman Biography and Mythology.

obedience to their father killed their husbands on their wedding-night, were punished in Tartarus by being compelled everlastingly to pour water into a sieve.

The idea of Tartarus becomes more definite in later classical writings. Hades was divided into Elysium, or the region of dawn, which was the abode of the good, and Tartarus, the region of night, which was the destination of the wicked. Virgil describes Tartarus in telling of the descent of Æneas to the under-world to visit his father (Æneid, vi, 548–627). It is in the form of a prison, inclosed with a triple wall. Phlegethon, a flaming torrent, rushes by the walls, whirling great rocks along in its course. The huge gate is swung between columns of adamant and from an iron tower. Tisiphone, with her bloody robe tucked up around her, watches the vestibule night and day. The great chasm is twice as deep as from earth up to heaven. Groans are heard issuing from the place, and the strokes of cruel lashes, the grating of iron, and the clanking of chains. Rhadamanthus judges the spirits on their arrival, and they are then turned over to the Furies for appropriate punishments, of which the torments of Ixion, Sisyphus, and a few others are given as examples.

According to the Scandinavian mythology, all who die bravely in battle are snatched away to Valhalla, Odin's magnificent banquet-hall in the sky. Those who, after lives of ignoble labor or inglorious ease, die of sickness, descend to a cold and dismal cavern beneath the ground, called Niflheim—i. e., the mist-world. This abode is ruled by the goddess of death, whose name is Hel. The place of torment for reprobates is Nastrond, deeper underground than Niflheim, and far toward the frigid north. This grim prison is described in the following passage from the Prose Edda, written in Iceland in the thirteenth century: "In Nastrond there is a vast and direful structure with doors that face the north. It is formed entirely of the backs of serpents, wattled together like wicker-work. But the serpents' heads are turned toward the inside of the hall, and continually vomit forth floods of venom, in which wade all those who commit murder or who forswear themselves."* According to the Voluspa, a poem of earlier date, the evil-doers in Nastrond are also gnawed by the dragon Nidhōgg.

The fathers of the Christian Church generally taught the existence of a hell of material fire and brimstone. Alger† gives as their belief that at the resurrection the damned "were to be banished forever to a fiery hell in the center of the earth, there to endure uncomprehended agonies, both physical and spiritual, without any respite, without any end." The strict literality with which these doctrines were held is strikingly shown in Jerome's

* Prose Edda, chapter lii.

† Future Life, p. 402.

artless question: "If the dead be not raised with flesh and bones, how can the damned, after the judgment, *gnash their teeth* in hell?" "Origen, who was a Platonist, and a heretic on many points," says Alger,* "was severely condemned for saying that the fire of hell was inward and of the conscience rather than outward and of the body." Tertullian says, "The damned burn eternally without consuming, as the volcanoes, which are vents from the stored subterranean fire of hell, burn forever without wasting."† These words point also to the belief, noted above, that hell was located under the earth.

In the middle ages the Christian conception of hell became more detailed and more terrible. The details can be found not only in the books of the period, but they were favorite subjects for miracle-plays and for works of art, especially for the pictures, carvings, and painted windows with which cathedrals were adorned. The monks of the period produced an extensive literature of visions describing the torments of hell. In these visions, according to Lecky—

> The devil was represented bound by red-hot chains on a burning gridiron in the center of hell. The screams of his never-ending agony made its rafters to resound; but his hands were free, and with these he seized the lost souls, crushed them like grapes against his teeth, and then drew them by his breath down the fiery cavern of his throat. Demons with hooks of red-hot iron plunged souls alternately into fire and ice. Some of the lost were hung up by their tongues, others were sawn asunder, others gnawed by serpents, others beaten together on an anvil and welded into a single mass, others boiled and then *strained* through a cloth, others twined in the embraces of demons whose limbs were of flame. The fire of earth, it was said, was but a picture of that of hell. The latter was so immeasurably more intense that it alone could be called real.‡

By far the most elaborate description of the punishments of sinners which the middle ages produced is that of Dante, whose Inferno combines the torments of the classical Tartarus and the horrors of the Christian hell. In this poem, which was written about 1300, the author represents himself as being conducted through the infernal regions by Virgil. Within the gates of hell, but before crossing the river Acheron, the visitors found those who had lived "withouten infamy or praise," and angels who had been neither faithful nor rebellious, but only selfish. They "were naked and were stung exceedingly by gad-flies and by hornets that were there."§ Beyond Acheron were found the great ones of old, whose sin was lack of baptism. These were "only so far punished that without hope we live on in desire" (iv, 41, 42). In the third circle, rain, snow, and hail constantly poured down

* Future Life, p. 516. † Apologia, cap. 47, 48.

‡ History of European Morals, vol. ii, pp. 235, 236.

§ Divine Comedy: Inferno, Canto III, lines 65, 66, Longfellow's translation.

upon the miry earth (vi, 10–12)—a truly dismal abode. Further on a group of the damned are confined in tombs made as hot by flames as iron need be for any art. Whenever a soul is cast into another circle it sprouts like a seed, and grows into a tree. The Harpies then cause it pain by feeding upon its leaves (xiii, 99–102). Soon a drove of sinners was met, followed by "horned demons, with great scourges, who cruelly were beating them behind" (xviii, 35, 36). In one place were a lot of holes in the rocky floor, in each of which a transgressor was stuck head downward, and as far as the calf, while the soles of his feet were frying with a greasy flame (xix, 13–30). In another place was a lake of boiling pitch in which souls were immersed, while demons stood round and kept them under the surface with gaffs (xxi, 16–57). Another group of lost ones had their hands bound with serpents, which were also biting and stinging their bodies (xxiv, 94–96). Others were driven round a ring, where each time they passed a devil would cut them open so that their bowels hung out, and the wound would close again while they were making the next circuit (xxviii, 22–42). In one of the inner circles, if from the hospitals, "all the diseases in one moat were gathered, such was it here, and such a stench came from it, as from putrescent limbs is wont to issue" (xxix, 49–51). Its denizens were scratching scabs from their sores as a knife takes the scales off a fish.

The punishments increase in severity with the descent to the inner and smaller circles of the vast amphitheatre. In the ninth and last circle, where traitors are punished, there is an ice-bound lake, into which the perfidious ones are frozen. "The emperor of the kingdom dolorous from his mid-breast forth issued from the ice." He is supergigantic in size, and has three faces on his head. In each mouth he crunches a sinner, but "To him in front the biting was as naught unto the clawing, for sometimes the spine utterly stripped of all the skin remained" (xxxiv, 55–60). The three arch-traitors distinguished by these supreme torments were Brutus, Cassius, and, the one in front, Judas.

The reformers made little change in the mediæval conception of hell. Calvin writes: "Forever harassed by a dreadful tempest, they shall feel themselves torn asunder by an angry God and transfixed and penetrated by mortal stings, terrified by the thunderbolts of God, and broken by the weight of his hand, so that to sink into any gulfs would be more tolerable than to stand for a moment in these terrors."

The characteristic austerity of the Puritans finds free scope in the depiction of hell's torments. Their great poet Milton describes the place in the first and second books of Paradise Lost. Satan and his host are cast into it "there to dwell in adamantine chains and penal fire."

"A dungeon horrible, on all sides round,
As one great furnace flamed; yet from those flames
No light, but rather darkness visible" (i, 61–63).

It is swept by "a fiery deluge, fed with ever-burning sulphur unconsumed." Besides a burning lake, it contains land or "firm brimstone"—that is, "if it were land that ever burned with solid, as the lake with liquid fire." From a hill on this land is dug ore of gold and other metals, which furnish the building materials for the magnificent palace Pandemonium, the high capital of Satan and his peers. In the second book are mentioned "four infernal rivers, that disgorge into the burning lake their baleful streams." Far away was Lethe, the river of oblivion, and "beyond this flood a frozen continent lies dark and wild, beat with perpetual storms of whirlwind and dire hail." Thither at intervals all the damned are brought to be tormented by extremes of heat and cold (ii, 597–601). When Satan, starting out to discover the earth, reaches the bounds of hell, he finds "thrice threefold the gates—three folds were brass, three iron, three of adamantine rock; impenetrable, impaled with circling fire, yet unconsumed."

The teaching of the Church of England in Milton's time did not differ much from that of the Dissenters. Jeremy Taylor devotes two chapters to deliberately recounting the most atrocious cruelties recorded in history, and asserts that they will be surpassed by the tortures in store for the wicked. A few instances will suffice:

Alexander, the son of Hyrcanus, caused eight hundred to be crucified, and while they were yet alive caused their wives and children to be murdered before their eyes, that so they might not die once, but many deaths. This rigor shall not be wanting in hell. . . . Mezentius tied a living body to the dead until the putrefied exhalations of the dead had killed the living. . . . What is this in respect of hell, when each body of the damned is more loathsome and unsavory than a million of dead dogs? . . . We are amazed to think of the inhumanity of Phalaris, who roasted men alive in his brazen bull. That was a joy in respect of that fire of hell. . . . The torment . . . comprises as many torments as the body of man has joints, sinews, arteries, etc., being caused by that penetrating and real fire of which this temporal fire is but a painted fire.*

The Puritans in America were no less emphatic in their depictions of hell than the parent stock in England. Many are the passages in the sermons of that stanch New England divine, Jonathan Edwards, devoted to setting forth the agonies of eternal punishment. The following extract is typical not only of Edwards, but also of his contemporaries:

Imagine yourself to be cast into a fiery oven, or a great furnace, where your pain would be as much greater than that occasioned by accidentally touching a

* Contemplations on the State of Man, Book II, chapters vi, vii.

coal of fire as the heat is greater. Imagine also that your body were to lie there for a quarter of an hour, full of fire, and all the while full of quick sense; what horror would you feel at the entrance of such a furnace! and how long would that quarter of an hour seem to you! And, after you had endured it for one minute, how overbearing would it be to you to think that you had to endure it the other fourteen! But what would be the effect on your soul if you knew you must lie there, enduring that torment to the full, for twenty-four hours! And how much greater would be the effect if you knew you must endure it for a whole year! And how vastly greater still if you knew you must endure it for a thousand years! Oh, then, how would your hearts sink if you knew that you must bear it for ever and ever!—that there would be no end!—that, after millions of millions of ages, your torment would be no nearer to an end, and that you never, never should be delivered! But your torment in hell will be immensely greater than this illustration represents.*

Among primitive peoples in various parts of the world, a variety of notions in regard to future punishment have prevailed. The African tribes which have not been affected by Mohammedan or Christian influence, although they may believe in future rewards and punishments, generally have no idea of definite places for heaven and hell. The Kamtchadales also have no hell. Of the American peoples, the ancient Mexicans affirmed that the wicked went to Mictlan, a dismal cavern within the earth. The Peruvian hell was also in the earth, and there the reprobate must endure centuries of toil and anguish. The Eskimo believe that hell is among the rocks, ice, monsters, and chilling waters of the sea. All souls must go down into it, but the good pass deeper to a more peaceful abode. The American Indians have no idea of a place of future torment except where it has been derived from white missionaries. "The typical belief of the tribes of the United States," says Brinton,† "was well expressed in the reply of Esau Hajo, great medal chief and speaker for the Creek Nation in the National Council, to the question, Do the red people believe in a future state of rewards and punishments? 'We have an opinion that those who have behaved well are taken under the care of Esaugetuh Emisee, and assisted; and that those who have behaved ill are left to shift for themselves; and that there is no other punishment.'"

No writer since ancient Egyptian times has given such a detailed theory of the future life as Swedenborg. In his book on Heaven and Hell, originally published in 1758, he says that punishments in hell are manifold; the more cunning and malignant of the damned domineer over the simpler. The faces of those in hell are deathly and dreadful: some are black, some fiery, some disfigured with pimples, warts, and ulcers; some have no face, only a hairy or bony surface. The "infernal heat is turned into

* Jonathan Edwards's Works, vol. vi, p. 99. † The Myths of the New World.

intense cold when heat from heaven flows in, and then the infernal inhabitants shiver like those who are seized with a cold fever." The hells are everywhere—under mountains, rocks, plains, and valleys. In the milder hells there appear to be cities of rude huts; in the huts are infernal spirits, engaged in continual quarrels, enmities, blows, and fightings; in the streets and lanes robberies and depredations are committed. In other hells there are forests, or deserts, or ragged rocks, or ruins as of burned cities.

Christian preachers and writers of the present time do not agree as to the nature of hell's torments. Many of them are coming to attach a figurative meaning to the biblical descriptions of hell, and seem as loath as their predecessors were eager to dwell upon the subject. In the Fortnightly Review for January, 1876, Lionel A. Tollemache says, "The wiser among us are seeking to drop hell out of the Bible as quietly, and about as logically, as we already contrive to disregard the plain texts forbidding Christians to go to law, and Christian women to plait their hair." Canon Farrar, in a series of sermons, has emphatically declared his disbelief in a hell of material and everlasting fire.

That widely known book Letters from Hell describes the place of torment as a country where the wicked are impelled to continually follow the same pursuits as in life; whatever they wish for is at once provided, amusements of all sorts are indulged in, but everything is empty and unreal, they are possessed by a constant hunger for pleasure which is never satisfied, tormented by memories of their lives on earth, driven from one thing to another to escape threatened misery, always on the verge of despair, and never by their feverish activity achieving even forgetfulness.

The Roman Catholic Church now, as always, holds that there are material torments in hell. The idea of hell which prevailed in Europe in the middle ages was that taught by the Catholic Church, which was practically the only form of Christianity at that time. An extremely realistic picture of hell is drawn in a Catholic tract, by the Rev. J. Furniss, C. S. S. R., published not long ago, with high ecclesiastical indorsement, "for children and young persons" in England and America. It is entitled The Sight of Hell, and describes little children turning and twisting in red-hot ovens, and screaming to come out.

The following statement of Catholic doctrine concerning hell is abridged from A Catholic Dictionary, by Addis and Arnold. Hell may be defined as the place and state in which the devils and such human beings as die in enmity with God suffer eternal torments. Theologians divide the punishments of the damned into that of loss and that of sense. The former is the deprivation of the vision of God. The devils and disembodied spirits of the damned suffer from material fire. The lost are afflicted also by

"the worm which never dies"—i. e., by the anguish of remorse; they are doomed to endure the society of others reprobate like themselves, and they know that all hope is over. After the resurrection the body also is subject to torment. It is certain that hell is a definite place, but uncertain where. Many of the fathers and theologians have held that it is in the center of the earth. Origen and some who followed him have thought that the punishment of the wicked would not be eternal, but a council has defined that the punishment of hell lasts forever.

Mr. C. H. Spurgeon, the celebrated English Baptist, says, in a sermon on The Resurrection of the Dead:

> There is a real fire in hell—a fire exactly like that which we have on earth, except that it will torture without consuming. When thou diest thy soul will be tormented alone in hell; but at the day of judgment thy body shall join thy soul, and then thou wilt have twin hells, body and soul together, each brimful of pain; thy soul sweating in its inmost pores drops of blood, and thy body, from head to foot, suffused with agony; not only conscience, judgment, memory, all tormented, but thy head tormented with racking pain, thine eyes starting from their sockets with sights of blood and woe; thine ears tormented with horrid noises; thy heart beating high with fever; thy pulse rattling at an enormous rate in agony; thy limbs cracking in the fire, and yet unburned; thyself put in a vessel of hot oil, pained, yet undestroyed.

Heine's Reisebilder contains a witty caricature of the orthodox hell, in which his satirical genius has free play.

The Presbyterian Confession of Faith teaches that the punishment of sin shall be separation from God, "and most grievous torments of soul and body, without intermission, in hell-fire forever."

That Unknown Country, a large octavo volume published in 1889, contains fifty chapters, each contributed by a living theologian as his views concerning punishment after death. These statements contain little description of the torments of hell; they are devoted mainly to discussing whether or no any of the condemned can shorten their term of punishment by repentance after death, and whether hell may not end with either the final salvation or annihilation of all the wicked. In this book Bishop Fowler, of the Methodist Episcopal Church, says that the popular conception of hell should be freed from the physical flames to be correct. Rev. Chauncey Giles (Swedenborgian) compares hell to an asylum for the incurably insane. Rev. Edward Everett Hale says, "No Unitarian supposes that life after death is limited in any way, so that one place in the universe can be mapped off as heaven, and another place mapped off as hell." Dr. A. A. Miner (Universalist) maintains that "punishment after death for the sins of this life is not taught in the Word of God." C. W. Pritchard, minister in the Friends' Church, Chicago, says, "Heaven is

place, and hades is a *place*," and calls the modern idea of hell "mystical, superspiritual view." Mr. Talmage, of Brooklyn (Presbyterian), asks: "What is the use of explaining away a furnace of fire, when God says there is one? . . . I am not opposed to saying it may be figurative; but I know very well that if it is not fire it is something as severe as fire. . . . God says it is fire, and a furnace of fire. Besides that, I do not know that it is figurative. It may be literal. The Bible sixteen times says it is fire." Dr. H. W. Thomas, pastor of the People's Church, Chicago, says that there is now a tacit admission on the part of even the orthodox churches that "the teachings of the past on this subject are not wholly true, and that, in some respects at least, they have to be modified or abandoned."

"The proprietor of a great foundry in Germany," says Alger, "while he talked one day with a workman who was feeding a furnace, accidentally stepped back, and fell headlong into a vat of molten iron. The thought of what happened then horrifies the imagination. Yet it was all over in two or three seconds. Multiply the individual instance by unnumbered millions, stretch the agony to temporal infinity, and we confront the orthodox idea of hell."* Mr. Alger maintains that the doctrine of a local hell, a guarded and smoking dungeon of the damned, ought not to be regarded as a truth contained in a revelation from God, because it is plainly proved by historic evidence to be a part of the mythology of the world, a natural product of the poetic imagination of ignorant and superstitious men.†

THE DISCOVERY OF INVISIBLE WORLDS.

By Dr. KLEIN.

SOME discoveries have very recently been made in the starry heavens which must be regarded, not only in what they are of themselves, but also on account of the way in which they were made, as among the most interesting of scientific events. It seems, in fact, like a contradiction to say that astronomers in Europe and America have been able to determine the velocity of motion, size, and weight of stars that are not visible in any telescope, and which no telescope to be made in the future, no matter how great its power may be, will be able to show. The new science also has the peculiar property that it recognizes mutual relations between objects apparently lying far from one another, connects with one another phenomena which appear to have no com-

* Future Life, preface to the tenth edition. † Future Life, p. 699.

mon measure, and draws fine lines of connection between earth and sky. One of these lines was drawn some thirty years ago in spectrum analysis; and by its aid man has risen in mind to remote worlds, and has sounded their physical and chemical constitution. The same spectrum analysis has now again celebrated a great triumph—a victory which might have been predicted, but the time for which did not seem yet to have come.

Every one is acquainted with the spectrum which we see when a ray of sunlight coming through a narrow opening passes through a prism. With the aid of suitable instruments there can also be seen in this spectrum a considerable number of dark cross-lines; and science has shown that these lines are caused by the presence of certain simple bodies or elements, including iron, hydrogen, sodium, etc. When we examine the light of the stars through those instruments, we shall perceive that in their spectrums too the dark lines denoting these elements are present. On this is founded the chemistry of the stars, for which we are wholly indebted to spectrum analysis. The situation of the dark lines in the spectrum is unchangeable, or else we would not be able to conclude from it respecting the elements represented there. The unchangeable character persists, however, only when the source of light is at rest as to the observer. If the shining body we are regarding is going away from us very rapidly, the dark lines incline to shift themselves slightly toward the red end of the spectrum; while, if it is approaching us with great rapidity, they slide over toward the violet. Without stopping to explain the causes of the shifting, we may remark that it is very small even with the greatest velocities. Former observers could hardly recognize it with certainty, because their instruments were not delicate enough to reveal such slight changes. Gradually makers have succeeded in constructing instruments that will show the changes with certainty. At the Greenwich Observatory, where observations of this kind have been carried on for several years, the motions in space of several stars have been ascertained with the help of the spectroscope. It has thus been found that the clear-shining Capella is receding from the earth at the rate of twenty-seven English miles a second, and that the brilliant star Vega in Lyra is approaching us at the rate of thirty-four miles a second. As such observations deal with infinitesimally small magnitudes, they are necessarily very difficult and precarious. It has been found, by investigations at the Astrophysical Observatory in Potsdam, that much more certain results are obtained if the spectrums of the stars are photographed and the measurements of the lines are made afterward on the pictures. These results have been confirmed by spectrophotographic researches at the Cambridge Observatory in North America; and thus the spectrographic method justifies the great-

t hopes. With this explanation we are prepared to understand e important discoveries that have been made at Potsdam and ambridge.

The bright star Mizar in the Great Bear is known to all. It is solved in the telescope into two stars, the bright star being ac- mpanied by a dimmer one, which is evidently a satellite, but pos- sses a period of revolution of about two thousand years. The ectrum of the principal star has been photographed several times nce 1887 at the Cambridge Observatory, Mass., and the photo- aphs have been carefully studied by Miss A. C. Maury, a niece of e celebrated Dr. Draper. The curious fact has been brought out at one of the photographed dark lines appears, at times, as if it as split into two fine lines. The doubling appears in the photo- aphs of May 29, 1887, and of May 17 and 27, and August 28, 1889. other photographs the lines appear washed out, as if they con- sted of two lines, yet not quite separated; while on still others ey appear clearly defined. On making up the registers of e times when the lines presented their different appearances, was found that they appeared double at intervals of fifty- o days, washed out a few days before and afterward, and other times single and sharp. By way of test the time was edicted when they should appear double again, and they came , true to the forecast. The other lines in the spectrum of izar are not very sharp, and some of them are very faint. Care- l examinations have shown that those few sharp lines also ap- ar somewhat washed and broader when the first line is doubled, hile the faint lines are at the same time very hard to see. The planation of these variations, according to Prof. Pickering, Di- ctor of the Cambridge Observatory, lies in the supposition that e chief star Mizar is itself a double star, whose components re- olve around one another in one hundred and four days, but are ill so close together that no telescope can separate them. They ppear even in the most powerful telescope only as a single round ar. When one of the two stars is moving toward the earth, all the nes in its spectrum are pushed toward the blue end; at the same me the second star, since both participate in the revolution, must receding from the earth, and the lines of its spectrum are pushed ward the red end. As soon, again, as the motion of the stars is rpendicular to a line drawn to the earth, all the lines will have eir normal position, and mutually cover one another; they will ppear single and distinct. The amount of the motion is calcu- ted, from the extent of the doubling, at a hundred English miles a second; from the period of revolution of one hundred and four ys, the circumference of the orbit is deduced to be 900,000,000 nglish miles, and the distance of the two stars apart 143,000,000 iles, or about the distance of the planet Mars from the sun. The

period of revolution of Mars is six hundred and eighty-seven days, and would be less if the mass or weight of our sun was greater. We can hence calculate how many times greater than the mass of the sun must be the mass of the two stars of Mizar for the revolution to be accomplished in one hundred and four days. The result is forty times the mass of the sun. So this little point of light which Mizar in the Great Bear appears to the eye is the equivalent of forty of our suns.

Before the news of this astonishing discovery made at Cambridge had reached Europe, a similar investigation made at the Potsdam Observatory was published. It was directed to the star Algol in the head of Medusa. This star has been known for more than two hundred years to be variable in brightness. It shines for two days and a half with a steady white light, then loses brightness for about four hours and a half, recovers during about four hours and a half, and then continues steady again for two days and a half. The changes go on with great regularity, and it has been believed for the last hundred years that Algol is attended by a double star revolving around it, by which it is concealed from the earth at regular intervals, depending on the period of its revolution. The periodical decrease of brilliancy is similar in its nature and cause to an eclipse of the sun, when the dark moon is interposed between it and the earth. But probable as this belief was, the fact had not been demonstrated. A complete solution has been obtained by spectrum analysis. Prof. Vogel, of the Astrophysical Observatory in Potsdam, and his fellow-worker, Dr. Scheiner, have taken photographs of the spectrum of Algol and carefully measured the dark lines. It has thus been ascertained that these lines move toward the red before the star appears at its weakest, toward the violet after that moment; or, in other words, that Algol is receding from the sun in the first half of its change, approaching it in the second half. This would necessarily occur if the star was describing an orbit around a dark body which should periodically conceal it for a time from our view. The rate of motion of Algol is twenty-three English miles in a second, and its period of revolution is two days, twenty hours, and forty-nine minutes; whence the circumference of its orbit and the distance apart of the centers of the two stars may be computed as was done in the case of Mizar. The latter is found to be less than 3,000,000 English miles, a small enough distance for two so large bodies. From the period of the light-changes and the velocity of the motion we calculate the diameter of the principal star to be 920,000 and of its dark companion 750,000 English miles. The two bodies which form the Algol system are each nearly as large as our sun, the diameter of the sun being taken at 750,000 miles, but their total mass is only about two thirds the mass of

he sun. We have, says Prof. Vogel, to think of these two bodies s surrounded by extensive atmospheres, and that that of the rincipal body, or Algol itself especially, must possess considerable lluminating power. Under certain presuppositions, the height of his atmosphere is estimated at 216,000 English miles, and that of he atmosphere of its dark companion at 168,000 miles. The small- st interval between the atmospheres of the two bodies will thus e 1,600,000 English miles, or less than can be found in our solar ystem. It is not easy, as Prof. Vogel suggests, to conceive two odies so near of nearly equal size, one of which is in the highest low of heat, and the other in a condition of far-advanced cooling. But the facts of observation lead to this conclusion, and in science acts constitute the highest and ultimate authority, before which verything must yield. Thus, we learn from the remarkable dis- overies in Potsdam and Cambridge that the world-order we meet n our solar system does not reign throughout the kingdom of the ixed stars, but that other relations come in which are quite dif- erent from those under which we live.—*Translated for the Popu- ar Science Monthly from Daheim.*

EVOLUTION AND THE DISTRIBUTION OF ANIMALS.*

By DAVID STARR JORDAN,
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II.

I was lately called to examine a specially interesting problem in geographical distribution, that of the dispersion of fishes in he Yellowstone Park. This region is a high volcanic plateau, ormed by the filling of a mountain basin with a vast deposit of ava. The streams of the park are for the most part among the oldest and clearest of the Rocky Mountains, and apparently in very way suitable for the growth of trout. All the hot springs f the great Geyser basin are not sufficient to warm the waters f the Fire-hole River. Yet, with the exception of the Yellow- tone itself, all these streams are destitute of fish-life. A reason or this is apparent in the fact that the plateau is fringed with ataracts which no fish can ascend. Each stream has a cañon nd waterfall near the point where it exchanges the hard bed of ava for the softer rock below. So the best of trout-streams, for n area of fifteen hundred square miles, are left without trout, ecause their natural inhabitants can not get to them.

On the theory that each species occupies those places best

* An address delivered before the Chicago Institute, in a course on the Testimony of cience in regard to Evolution.

suited to its life, this fact would represent a great oversight on the part of Mother Nature. But with this is the curious fact that the Yellowstone itself, both above and below its falls, is well stocked with trout and with no other fish. This is an anomaly of distribution, but this anomaly disappears when we examine the continental divide as it appears at the head of the Yellowstone. At one point, the Two-Ocean Pass, only about an eighth of a mile of wet meadow and marsh separates the drainage of the Yellowstone from that of the Columbia. From the Columbia the Yellowstone has therefore received its trout. No doubt every anomaly of distribution would become perfectly simple could we only know all the facts which bear on the case.

In my studies of the fishes of America I have had occasion to especially investigate the barriers to their distribution, and the relative value of these as limiting the range of the different forms.

In general we may say that, with rare exceptions, in all waters not absolutely uninhabitable, there are fishes. The processes of natural selection have given to each kind of river or lake species of fishes adapted to the conditions of life which obtain there. There is no state of water, of bottom, of depth, of speed of current, but finds some species with characters adjusted to it. Each of these species has an ascertainable range of distribution, and within this range we may be reasonably certain to find it in any suitable waters.

But every species has beyond question some sort of limit to its distribution, some barrier which it has never passed in all the years of its existence. That this is true becomes evident when we compare the fauna of widely separated rivers. Thus the Sacramento, Hudson, St. Johns, and Rio Grande have not a single species common to any two of them. None of them has any species peculiar to itself, and each one shares the greater part of its fauna with the water-basins nearest to it.

With the shore fishes, as with other water animals, the barriers are primarily the heights of the land and the depths of the sea—physical obstacles not to be crossed. Next in importance is the barrier of climate. With some forms of life this is absolute, for the palm and the banana are the index of the torrid zone as the dwarf birch and reindeer moss are the index of the frigid. "Plants," says Dr. Gray, "are the thermometers of the ages by which climatic extremes and climates in general are best measured." In many groups anatomical characters are not more profound or of longer standing than are the adaptations to heat and cold. Heat-loving animals are far more numerous in species than animals of cold climates, though the latter often make up by greater abundance of individuals. Barriers less important

than those of climate arise from external surroundings—from absence of means of defense, from character of food, of air, of water, and the presence of various enemies. These conditions vary in their importance with each group of animals, yet apparently the least of them may be able to limit the range of species. To limit the range is the first step toward extinction, for to cease to advance is to retreat. Adverse conditions may invade even the heart of its distribution, causing reduction of numbers, which, if long continued, must mean rarity and final extermination. Extinction comes to those species we call rare, and its advent must be unnoticed. Circumstances become unfavorable to the growth or reproduction of some animal. Its numbers are reduced —it is rare—it is gone.

The air in Indiana but a few years since was dark with the hordes of passenger pigeons at the time of their fall migrations. The advance of a tree-destroying, pigeon-shooting civilization has gone steadily on, and now who has seen a passenger pigeon? I have seen them, and I have a skin or two in my collection, but the bird I knew as filling the trees in my boyhood is now in the same region an ornithological curiosity.

A very slight change in the environment of any species may be a matter of the greatest moment as regards its increase or permanence. The dependence of the clover on the number of cats in a certain neighborhood is an illustration given us by Mr. Darwin. The clover depends on the bumble-bee for the fertilization of its pods. The nests of the bumble-bee are destroyed by the field-mouse, which is thus an enemy of the clover. The balance is restored by the work of the cat, who captures the mouse and prevents its ravages on the nests of the bee. The old nursery jingle of the cow that tossed the dog that worried the cat that killed the rat is repeated throughout nature. With any change in any of the elements in this series the whole equilibrium of nature is interrupted. For this equilibrium is apparent only—a sort of armed neutrality, an established order of things which the superficial observer mistakes for real peace and permanence.

In some groups we find evidence of a progressive adaptation of individuals to circumstances—for example, to climate, ending in the formation of new species to accord with changed conditions of temperature. We may illustrate this by means of the arctic birches. In Norway, as in most northern regions with a moist climate, there are large forests of birches. In the valleys, where the summers are warm and reasonably long, the birches of different species grow to be considerable trees. Farther to the north, or higher up the mountains, the summer is too short for the growth of birch-trees, and their place is taken by birches which never pass beyond the size of small bushes. Still higher up there

are birches even where snow falls during every month of the year, and the distant sun gives only a glimpse of summer in July. Competition with other plants is, of course, not severe in such regions, but the birches must struggle against the weather. They can live and multiply, if only they can adjust themselves to the conditions of life. They must keep down their size, they must carry as little foliage as possible, and their stems must be tough enough to resist snow, and hardy enough to withstand almost perpetual frost. Their year's growth must be finished in a very short time, and leaves, flowers, and seeds must follow in the most rapid succession. In short, there is room for birch-trees here, if only the trees can be reduced to their lowest terms. And so birch-trees have crept up the mountain-sides even to the very edges of the perpetual snow. But such trees! All trees requiring sunshine, or long time for their summer's growth, are rigidly kept away by "natural selection." The cold climate dwarfs the individual, and the hard conditions exclude every individual not dwarfed. I have before me three birch-trees from a Norwegian mountain called the Suletind—the little trees known to the Norwegian peasants as "Hundsöire," or "dogs'-ears." The trunk of each tree is barely an inch in height. There are no branches, and but three leaves. Half inclosed by the uppermost leaf is the single little catkin of flowers. Leaves in June, blossoms in July, fruit in August, and then the little tree is ready for its nine months' sleep. These little trees are the Lapps of forest vegetation.

All natural history is full of similar cases of modifications. Everywhere there is the most perfect adaptation of life to its conditions. But this adaptation must come about through the survival of those organisms fittest to live under the conditions, while the unfit die out and leave no progeny. But fitness is a relative term; for in many cases, as with the Norwegian dwarf birches, the deformed or stunted may be the only ones fitted to survive. An advantage ever so slight must in the long run conquer. The gambler recognizes that final victory must always go with the percentage of the dealer.

The restlessness of individuals is the key to all these problems. Each species of animal or plant is first the product of heredity, and then of the various influences, reactions, and extinctions to which we give the name of natural selection. Each species may be conceived as making every year inroads on territory occupied by other species. If these colonies are able to hold their own in the struggle for possession, they will multiply in the new conditions, and the range of the species becomes widened. If the surroundings are different, new species or varieties may be formed with time; and these new forms may invade the territory

of the parent species. Again, colony after colony of species after species may be destroyed by other species or by uncongenial surroundings.

Only in the most general way can the history of any species be traced; but, could we know it all, it would be as long and as eventful a story as the history of the colonization and settlement of North America by immigrants from Europe. Each region where animals or plants can live has been thousands of times discovered, its colonization a thousand times attempted. In these efforts there is no co-operation. Every individual is for himself, every struggle a struggle of life and death; to each species each member of every other species is an alien and an enemy.

The arctic birches serve as one illustration only of the spread and change of organisms in the face of a barrier apparently insurmountable. I can not enter into detail as to the many ways in which individuals manage to cross the barriers which usually limit the species. These ways are as varied as the creatures themselves, and infinitely more varied than the barriers. It is enough to say that organisms have extended their range in regions where their existence is possible. Here, by the long-continued process of adjustment to circumstances, with the incessant destruction of the unadapted, these organisms have become so well fitted to their surroundings as to give rise to the popular impression that each species now inhabits that part of the world best fitted for its occupation. Yet the very reverse of this must be true, for in the growth of any species it is these features of adaptation which are the last to appear. If, as anatomists now teach, the history of the individual is an epitome of the history of the group to which the individual belongs, then adaptive characters appearing late in the growth of the individual must have appeared late in the history of the group. They are the last changes made in the organism—mere after-thoughts in the work of creation.

For example, the long pectoral fins of the flying-fish enable it to make great leaps through the air, after the manner of the grasshopper. Yet we can not say that the flying-fish was meant to be the bird among fishes, for its nearest relatives are without wings, and the wing-development is one of the last acquisitions of the individual. Its flight is simply an exaggeration of the leaping or skimming which related forms with shorter fins accomplish. The growth of the fins goes on with the increase of this power, and greater power comes with the growth of the fins.

To my mind the strongest arguments for the theory of development are those drawn from the changing character of the species themselves.

No phase in the history of systematic science is more instruct-

[illegible]

[illegible] species [illegible] [illegible] [illegible]

founded variation, which, however, is pleasant to me as a specialist, though odious as a systematist. . . . How painfully true is your remark that no one has hardly a right to examine the question of species who has not minutely described many! . . . Certainly I have felt it humiliating, discussing and doubting and examining, over and over again, when in my mind the only doubt has been whether the form varied to-day or yesterday. . . . After describing a set of forms as distinct species, tearing up my manuscripts and making them one species, tearing that up and making them separate, and then making them one again (which has happened to me), I have gnashed my teeth, cursed species, and asked what sin I had committed to be so treated."

An epoch in systematic zoölogy began with the study of the collections made by the United States Pacific Railway Survey some thirty years ago. This was the first opening out to naturalists of the details of the fauna of a vast district under the same parallels of latitude, but showing every variation in rainfall, elevation, and physical surroundings. The most valuable results of these collections were seen in the study of birds. It was found in general that each bird of the Atlantic States had its counterpart in the prairies, the sage-plains, the mountains, and the Pacific slope. Differences were carefully sought for and found, for the school of Prof. Baird allowed nothing to escape their analysis. There were differences in size, in form and color, slight in degree, but nevertheless really existing, and these were made the basis of as many distinct species. Still further studies increased the number of these species, until at last a large proportion of our birds were represented by Eastern, Western, sage-brush, and prairie species. Sometimes these closely connected forms were distinguishable at first sight, as in the case of the yellowhammer, and its double, the red-shafted flicker; in other cases baffling the most skillful, as with the two species of the crow-blackbird.

An illustration of these forms and their relations may be taken from the common shore lark and its varieties, although it is fair to say that some of these variations have never been regarded as species.

The shore lark, or horned lark (*Otocoris alpestris*), ranges widely over the colder and open parts of Europe, Asia, and America. The common form, called *alpestris*, is familiar to most of us. In the Northwestern region, as far south as Utah, is another form, equally large, but paler in color (*leucolæma*). In the prairie region the lark is of the ordinary color, but smaller (*praticola*). In the sage-plains, it is a similarly small but pale lark, with brighter yellow in its throat; this is *arenicola*. In Texas the bird is still smaller and grayer (*giraudi*); while the small form found in New Mexico and Arizona has its plumage strongly washed with red;

this is *chrysolæma*. In the interior of California the shore larks are still smaller and redder (variety *rubea*), while northward and coastwise appears a small lark with more streaked plumage; this is *strigata*. All these can be generally recognized by an expert ornithologist, and doubtless a closer analysis would reveal the basis for still finer subdivisions.*

In 1871 Dr. Joel A. Allen published his masterly paper on the Mammals and Winter Birds of Florida. This memoir has had the practical effect of making all our ornithologists, for the most part against their will, believers in the theory of derivation of species.

Dr. Allen took up, as a matter of serious study, the variations in individual birds. He showed that the variation of individuals of the same species was far greater than had been supposed, and that the characters relied on to distinguish species were often due to slight increase in these variations. For example, in Northern birds the bodies would be larger, the bills smaller than in birds of the same species from the South, and the coloration of birds was often directly related to the degree of rainfall. He showed, in brief, that each one of these many variations must be held to define a distinct species, or else that the number of species of American birds would have to be greatly reduced, and the range of variation inside the species would need to be correspondingly extended.

This claim for attention on the part of the despised variety produced much consternation among students of birds. But facts must be recognized; and the final result has been, that we have now extended our idea of each species until it is large enough to include all that we know of intermediate and varying forms. When a hiatus appears, whether existing either in fact or in our material for study, there we put our line of definition. "We can only predicate and define species at all," says Dr. Coues, "from the mere circumstance of missing links. Species are the twigs of a tree separated from the parent stem. We name and arrange them arbitrarily, in default of a means of reconstructing the whole tree in accordance with Nature's ramifications." †

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* In the Auk for April, 1890, is an essay on the Horned Larks of North America, by Jonathan Dwight, Jr. Mr. Dwight's conclusions are based on 2,012 specimens; those of Mr. H. W. Henshaw, above given, on 350. To the forms mentioned above, Mr. Dwight adds *var. adusta*, small, and "scorched pink" in general hue, from southern Arizona and northern Mexico; *var. menilli*, large and dusky, in Idaho and neighboring regions; and *var. pallidus*, very small and pale, from Lower California.

† Dr. Allen says, in a recent paper: "We arbitrarily define a species as a group of individuals standing out distinct and disconnected from any similar group, within which, though occupying different parts of the common habitat, we recognize other forms characteristic of and restricted to particular areas. These reach a maximum degree of differentiation at some point in the habitat, and thence gradually shade into other con-specific forms geo-

What is true of birds is equally the case with other groups of animals. Continued explorations bring to light each year new species of American fishes, but the number of new forms discovered each year is usually less than the number of old supposed species which are found to intergrade with each other, and have so become untenable.

I have myself published three complete lists of the fresh-water fishes of North America. The one published in 1876 enumerated 670 species; that of 1878, 665 species; while the list of 1885 contained 587 species, although upward of 75 new species had been found in the nine years which elapsed between the first and the last of these three lists.

The old idea of a species as a separate entity, a special creation, has passed away forever. We can no more return to it than astronomers can return to the Ptolemaic notion of the solar system. The same lesson comes up from every hand. It is the common experience of all students of species. We have learned it from Gray and Engelmann and Coulter, and from each of the many students of American botany. We have learned it from Baird and Allen and Coues and Ridgway and Stejneger, and from all who have made life-studies of American birds. We have learned it from Cope and Marsh and Leidy, and from all who have searched the rocks for the bones of our ancestors.

I do not know of a single naturalist in the world, who has made a thoughtful study of the relations of species in any group, who entertains the old notion as to their distinct origin. There is not one who could hold this view, and look an animal in the face! The study of the problems of geographical distribution is possible only on the theory of the derivation of species. If we view all animals and plants as the results of special creations in the regions assigned to them, we have, instead of laws, only a jumble of arbitrary and meaningless facts. We have been too fully accustomed to the recognition of law to believe that any facts are arbitrary and meaningless. We know no facts which lie beyond the realm of law. I may close with the language of Asa Gray:

"When we gather into one line the several threads of evidence of this sort to which we have here barely alluded we find that they lead in the same direction with the clews furnished by [other lines of investigation]. Slender indeed each thread may be, but they are manifold, and together they bind us firmly to the doctrine of the derivation of species."

[*Concluded.*]

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graphically contiguous."—On the Recognition of Geographical Forms; The Auk, January, 1890, p. 7.

CENTERS OF IDEATION IN THE BRAIN.*

By BERNARD HOLLANDER.

ON the 22d of February, 1887, Prof. David Ferrier delivered an address in this room on the question, "How far recent investigations on the functional topography of the brain could be brought in relation with craniological and anthropological researches with a view to establish the foundation of a scientific phrenology." It is my object to-night to continue that discussion, and to submit to you the basis of a scientific phrenology for your examination and criticism. I take it for granted:

1. That all mind-manifestation is dependent on brain-matter.

2. That the various elements of the mind have distinct seats in the brain, which, however, have not been as yet determined.

3. That the recent researches by physiological experimenters and pathological investigators—which have resulted in defining distinct regions for motion and sensation—established the physiological correlative of psychological actions.

By applying galvanic currents to definite portions of the brain, or by destroying certain areas, physiological experimenters cause movements of certain limbs and muscles. In itself the distribution of motor areas in the brain would be of little value to the psychologist except that it proves to him the plurality of functions of the brain. When, however, we observe that the movements caused by excitation form the physical parallel of a mental action, we may arrive at the psychological function of a certain portion of brain by reducing the various faculties of the mind to their elements, and watching their physical expression. No galvanic current will ever have the effect of demonstrating a center of ideation—say the center for the emotion of power; on the other hand, there are several emotions and all the higher intellectual operations, which have no outward physical signs. All which the excitation of that portion of brain where the emotion of power may have its center can effect is certain movements which such an emotion would cause when irritated.

To arrive, then, at the demonstration of centers of ideation there is but one way:

1. We must observe the physical expression of our thoughts and feelings, as far as possible; in other words, we must study the outward visible signs of their manifestation.

2. We must take the limbs and muscles, which are affected by definite emotions, and see on what occasions they are made to move by central excitation.

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* A paper read before the Anthropological Institute, London, February 12, 1889.

Let me give an example. The outward sign of a joyful emotion is a drawing up of the corners of the mouth. The elevation of the angles of the mouth is the muscular action going parallel with the emotion of joy. The excitation of the nerve-center causes the elevators to act. There is but one definite area from which the elevator muscles can be made to act, therefore joyful emotions must take their start from this center. When, then, a joyful emotion excites this definite portion of gray matter, a nerve-current passes to the lower center—the center for the movements of the elevator muscles—and causes them to act. As the brain is a very complex machine, other effects may be produced at the same time, but this one has always been associated particularly with exhilarating emotions. Persons of very cheerful dispositions make the elevators act so frequently that the mechanism of the nerve-display is facilitated by constant use, and the center will easier appreciate these special impressions. The elevators will be in time so accustomed to act that they will leave impressions on the face so marked to enable people to recognize, by mere physiognomical signs, their brethren who are of such disposition.

Now, let us see what the actual experiments were.

Prof. Ferrier applied a galvanic current to the ascending frontal convolution in monkeys on a definite portion, marked 7 (Fig. 1), and to the corresponding region in dogs, jackals, and cats, all with the effect of elevating the cheeks and angles of the mouth with closure of the eyes. On no other region could the same be effected.

FIG. 1.—DIAGRAM. (David Ferrier.)

(7) Center for the movements of the elevator muscles.
(15) Gustatory center.
(11) Center for movements of the "platysma myoides muscle."
(5) Center for movements of the arm and raising of the shoulder. (Patience muscles.)

Darwin (Expression of the Emotions, p. 202, etc.), says: "Dr. Duchenne repeatedly insists that under the emotion of joy the mouth is acted on exclusively by the great zygomatic muscles, which serve to draw the corners backward and upward. The upper and lower orbicular muscles are at the same time more or less contracted. A man in high spirits, though he may not actually smile, commonly exhibits some tendency to the retraction of the corners of his mouth. According to Sir Charles Bell, in all the exhilarating emotions the eyebrows, eyelids, the nostrils, and the angles of the mouth are raised. The tendency in the zygomatic

muscles to contract under pleasurable emotions is shown by a curious fact communicated to me by Dr. Browne with respect to patients suffering from general paralysis of the insane: 'In this malady there is almost invariably optimism — delusions as to wealth, rank, grandeur—insane joyousness, benevolence, and profusion, while its very earliest physical symptom is trembling at the corners of the mouth and at the outer corners of the eyes. This is a well-recognized fact.'"

We have, then, sufficient evidence that the effect produced by a galvanic current on the portion of brain marked 7 in Ferrier's

FIG. 2.—DIAGRAM OF CRANIO-CEREBRAL RELATIONS. (Reid.)

Some of the results of observations made by the early phrenologists:

a, *Hope:* the organ of cheerfulness.
b, *Imitation:* the organ of mimicry.
c, *Alimentiveness:* the gustatory organ.
d, *Cautiousness:* the organ of circumspection, fear, timidity.
e, *Veneration:* the organ of submission, respect, devotion.
f, *Attachment:* the organ of friendship.

Some of the results of experiments made by modern physiologists:

a, Center for the movements of the *elevator muscles* (elevating the cheeks and angles of the mouth).
b, *Facial Nerve Center:* center for facial movements.
c, *Gustatory Center.*
d, Center for movements of the *platysma myoides*, the muscle of fright.
e, Center for movements of the arm and raising of the shoulders. *Patience Muscles.*

topography is the physical expression of joy. We know, then, for positive that pleasurable emotions excite this center. But I do not say that it is the function of the center to produce an emotion of joy—a manner after which the old phrenologists would have expressed themselves—I merely note that all pleasurable emotions produce a nerve-current, which takes its start in this region.

Sir Crichton-Browne tells us that, in general paralysis of the insane, there is invariably optimism, beginning generally with trembling at the corners of the mouth and the outer corners of the eye. The old phrenologists located "hope" in this region (*a*, Fig. 2), and there is, no doubt, a strong relation between hope and optimism; and I find, in the writings of Combe, frequent allusions that this organ gave a tendency to cheerfulness. At the same time I must note that Gall, the founder of phrenology, did not admit "hope" as a faculty, but included this portion of brain in his organ of "imitation," or "center for mimicry," of which I shall speak directly.

There are many defects in the old phrenological system; one of them being that it rather favored complex functions. But, all the same, an unprejudiced investigator must take their observations into consideration. I need not remark that, when I refer to phrenology, I mean only the observations of Gall, and not the fancies and fallacies of his followers.

This center for the elevator muscles, and probable center from which exhilarating emotions take their start, is in close connection with Exner's center for the facial nerve.

Ferrier's center, No. 7, is a little lower than the center for the "nervus facialis" as located by Exner (Localisation der Functionen in der Grosshirnrinde des Menschen, Wien, 1881). The "nervus facialis" center occupies a very large portion of brain in Exner's collection of pathological evidence. The most intense centers for facial movements are localized by him in the squares marked 57, 58, 65 (Fig. 3), but are said to extend actually from the gyrus centralis anterior to the latter halves of the lower frontal convolutions. He quotes many cases of disease of this nerve, and is particularly struck with the frequency with which disease of the facial nerve and aphasia concur. He says (page 56) it can not be mere chance that paralysis of the facialis is frequently accompanied by aphasia and the reverse—an observation which was also made by Ferrier.

There is sufficient evidence that the center for the facial movements occupies an area extending from the ascending frontal convolution to the middle frontal convolution—a fact which was noted by Gall. He located in this region the talent for mimicry, the talent of imitating the gestures of other people (*b*, Fig. 2); more than this, he noted that, when this region was prominently developed, there was not only a talent for mimicry, but also a talent for the imitation of the voice of other people, and many examinations and casts of heads of eminent actors were made to prove this theory.

We have heard from Exner and Ferrier how closely the speech and facial nerve centers are connected; both in perfection

being necessary for a clever actor. But let me quote Gall himself. Speaking of a man with a peculiar prominence of this region, he says:

"He imitated in so striking a manner the gait, the gestures, the sound of the voice, etc., that the person was immediately recognized. I hastened to the institution for the deaf and dumb to examine the head of the pupil Casteigner, who had been received into the establishment six weeks previous, and who, from the first, had fixed our attention by his prodigious talent for imita-

FIG. 3.—DIAGRAM. (Sigmund Exner.) The darkest squares are Nos. 57, 58, 65, and are the most intense centers for the movements of the facial muscles.

tion. On Shrove-Tuesday, when a little theatrical piece is usually represented in the establishment, he had imitated so perfectly the gesture, the gait, etc., of the directors, inspector, physician, and surgeon of the institute, and especially of some women, that it was impossible to mistake; a scene which amused the more, as nothing like it was expected from a boy whose education had been absolutely neglected."

He goes on to explain that many men have a natural talent for the stage or pantomime, and that the history of the lives of great actors shows that the majority of them had received little education and were intended for some other profession, but their innate disposition drove them to the stage. The faculty of imitation is exercised sometimes even in idiots and madmen. Pinel says:

"A young idiot, whom I have long had under my eye, has the most marked and irresistible inclination to imitate all that she sees done in her presence; she repeats mechanically all that she hears said, and imitates with the greatest fidelity the gestures and actions of others, without much regard to propriety."

I can not go into details to-night as to the ample evidence, pathological and otherwise, which the early phrenologists brought forward in their time. They were only ridiculed and treated as charlatans. To-day people know nothing of the old phrenology, except what they hear from opponents and read in books by some phrenological dilettanti. Scientific men think Gall's theory exploded, because Sir William Hamilton and Flourens appeared to disprove it; but we know, since 1870, that the doctrines of these two men are equally valueless, for Flourens taught that the whole brain acted as an organ of the mind, and not, as we know now, that special parts of the brain have separate functions; while Sir William Hamilton considered it impossible to form a system on the supposed parallelism of brain and mind. L. Landois (Lehrbuch der Physiologie) recommends a re-examination of Gall's theories, and I hope to show you to-night that, whatever you may think of the phrenological system, Gall's fundamental observations were correct.

Ferrier's experiments on monkeys on the anterior and inner aspect of the uncinate gyrus, marked 15 (Fig. 1), had the effect of "torsion of the lip and semiclosure of the nostril on the same side, as when the interior of the nostril is irritated by some pungent odor." He says (page 244, The Functions of the Brain, London, 1886):

"Irritation of the middle temporo-sphenoidal convolution I have found in general to be without any obvious reaction except toward the lower extremity, where in several instances movements of the tongue, cheek-pouches, and jaws were induced very much like those which are characteristic of tasting."

The same experiment on 15, the uncinate gyrus or extremity of the temporal lobe of dogs, had the result of "torsion of the nostril on the same side, as if from irritation directly applied to the nostril." The same effect was produced by experiments on cats and other animals. He continues:

Page 315: "As above described, irritation of the hippocampal lobule in the monkey, cat, dog, and rabbit was attended by essentially the same reaction in all, viz., a peculiar torsion of the lip and nostril on the same side. This reaction is precisely the same as is induced in these animals by the direct application of some strong or disagreeable odor to the nostril, and is evidently the outward or associated expression of excited olfactory sensation."

Page 321: "As to the sense of taste, I have not succeeded in

differentiating any special region related to this faculty, but that it is in close relation with the olfactory center is probable from the facts described. It was noted in connection with electrical irritation of the lower extremity of the temporo-sphenoidal convolutions in the monkey, and of the same region in the brain of the cat, that movements of the lips, tongue, cheek-pouches, and jaws were occasionally induced—phenomena which might be regarded as indications of the excitation of gustatory sensation. This interpretation receives support from the above-described results of destructive lesions; and we have, therefore, reasonable grounds for concluding that the gustatory centers are situated at the lower extremity of the temporo-sphenoidal lobes, in close relation with those of smell."

Page 431: "The physiological needs of the organism, in so far as they induce locally discriminable sensations, express themselves subjectively as definite appetites or desires, which are the conscious correlations of physiological wants. The appetite of hunger is the desire to satisfy or remove a local sensation, referable to the stomach, in which the physiological needs of the stomach express themselves. The substrata of the feeling of hunger and appetite for food are the stomachic branches of the vagus and their cerebral centers; and, as local conditions of the stomach may destroy or increase the feeling of hunger, so central disease may give rise to ravenous appetite or sitophobia, conditions exemplified in certain forms of insanity."

Ferrier thus proves the tip of the lower temporal convolutions to be the "gustatory center"; and even Hitzig, who is not always flattering to Prof. Ferrier, delights in noting this discovery. Yet I will show you immediately that this center—of which we are most certain—was known and correctly localized in the same portion of brain by the early phrenologists.

Many men claimed the discovery of the organ called "gustativeness," or "alimentiveness," but the editors of the Edinburgh Phrenological Journal, vol. x, page 249, give Dr. Hoppe, of Copenhagen, the credit of having been the first and most acute observer.

"In December, 1823, he expresses the opinion that, besides the nerves of the stomach and palate, of which alone he conceives the sensations of hunger and thirst to be affections, there must be also an organ in the brain of animals for the instinct of nutrition for the preservation of life, which incites us to the sensual enjoyments of the palate, and the activity of which is independent of hunger and thirst."

In a second communication to the same journal, dated 28th December, 1824, he says:

"Regarding the organ for taking nourishment, I have been led

to think, since I wrote last, that the place where its different degrees of development are manifested in the living body is in the fossa zygomatica (*c*, Fig. 2). Before I had thought at all of phrenology I was struck with the remarkable breadth of the face or head of a friend of mine, caused, not by prominent cheekbones, as in some varieties of mankind, but more toward the ears, by the great convexity of the zygomatic arch. Knowing that this individual was exceedingly fond of good living, and that, even in spite of a very powerful intellect, and propensities moderate in almost every other respect, he was prone to indulge too freely in the joys of the table, I afterward thought that this form of the head and tendency of the mind might bear a nearer relation to each other than had at first occurred to me; and in some other persons, notoriously fond of good eating and drinking, I found a confirmation of my suppositions. This prominence of the bony arch, I think, must be an absolute consequence of the part of the cranium lying under the temporal muscle being pushed outward, and diminishing in that direction the space of the fossa."

Dr. Hoppe considered the organ "alimentiveness" to be likewise the organ of taste. He says:

"That the sensation of taste only passes through the nerves and is perceived in a part of the brain is a supposition, I think, sufficiently proved. Now, it appears to me as highly probable, and by analogy agreeing with other experience, that it is one and the same organ which tastes, viz., distinguishes and enjoys, and incites us to taste, or, in other terms, to take food and drink. This, according to my opinion, is the organ of appetite for food, and consequently it may be named the organ of taste, gustus."

Dr. Crook, of London, mentions that, several years before the publication of Dr. Hoppe's papers, he himself had arrived at similar conclusions with regard to this faculty and the position of its organ. He says:

"Three persons with whom I had become acquainted in the year 1819, first led me to suspect that a portion of brain situated near the front of the ear was connected with the pleasures of the festive board. From that time to the end of 1822 above a thousand observations were made. As they tended to confirm this view, several phrenological friends were informed of the result. From 1823 I no longer doubted that the anterior portion of the middle lobe was a distinct organ, and that its primary use was the discrimination and enjoyment of meats and drink. It was difficult, however, to hit the fundamental power. The situation of the organ, under the zygomatic process and the temporal muscle, frequently precluded the possibility of accurate observation. But, notwithstanding, well-marked cases, both of a positive and a negative kind, were investigated."

A long controversy follows this paper on "alimentiveness," the gustatory center, in the Phrenological Journal, and much ridicule was thrown at the originators for localizing a center for hunger and thirst, those affections being thought due to the stomach alone. Even to-day scientific men say phrenology is exploded, because certain thicknesses in the skull and the various muscles make it impossible to distinguish the corresponding portions of brain; yet it is remarkable that the organ which has been ridiculed most, and which was the most difficult to observe, is to-day found correct.

If there were but two organs correctly localized by Gall, it would justify a reconsideration of his work; but there seems to be a number of faculties, the localization of which has been confirmed by modern experiments. Unfortunately, the later phrenologists have spoiled many of Gall's original observations. I will just give a few more examples, in order that my paper may receive sufficient consideration, and may effect a change in your views with regard to the old phrenology.

Prof. Ferrier's experiments on "the lower extremity of the ascending parietal convolution" in monkeys, marked 11 (Fig. 1), resulted in "retraction of the angle of the mouth. The action is that of the platysma myoides."

Darwin (Expression of Emotions, page 298) says with regard to the physical expression of "fear," and the platysma myoides muscle:

"Sir Charles Bell (Anatomy of Expression, page 168) and others have stated that this muscle is strongly contracted under the influence of fear; and Duchenne insists so strongly on its importance in the expression of this emotion that he calls it the muscle of fright."

This may perhaps suffice to show that the platysma myoides muscle is called into action in the expression of fear.

Now let me draw your attention again to the old phrenology. Gall located so-called "cautiousness" in an area which covers not only Ferrier's center 11, but also the angular gyrus (*d*, Fig. 2). He found an enormous development of this region in persons known for their timidity, persons known to take alarm easily, and who could be easily terrified.

As to the function of the angular gyrus, physiologists are not agreed. Ferrier includes the gyrus in his center of sight. Munk calls it "Seelenblindheit"—a strange name with a still stranger meaning.

I will quote some passages which seem to indicate that the effects produced by lesion of this region have some connection with the function attributed to it by phrenologists.

Ferrier, Philosophical Transactions, 1875, Part II, pages 445–451,

umé: "After destruction of the angular gyrus the animal mences to feel about cautiously; if pushed to move, it runs inst every obstacle on its way. If put on the floor, it cries out looks about quite frightened. If called, it points its ears and s. If taken up again, it clings to one as if afraid of being put n. On the other hand, threatening with the stick has no t unless the stick is brought in contact with the eyes."

Munk (Functionen der Grosshirnrinde, page 25 etc.) makes same observations as Ferrier, only his region of destruction, ked A_1 (Fig. 4), includes a portion of brain where Gall located organ of "friendship" or achment" (*f*, Fig. 2); and nk, speaking of the effect, : "However, the animal re- ns cold at the sight of men, m it used to greet most ndly, and even at the sight logs, with whom it used to "; an effect which can be ly explained on phrenologi- principles by the loss of organ of "attachment" or endship." He goes on to re- k that the whip, which for- ly frightened the animal y to a corner, has now no t. The animal stops before y obstacle on its path and s back again; one has to it to go up any steps, and it feels its way with its , though not blind. When vering, it stares at every- g and examines every object most cautiously, both when lying n and walking about, just as if it had to learn afresh and gain experience.

FIG. 4.—DIAGRAM. (Hermann Munk.) Extirpation of area marked A_1 causing loss of social attachment, and of the emotion of fear.

Goltz (Verrichtungen des Grosshirns, page 18, etc.) says it is ell-known fact that animals are easily put into rage by the earance of a person in strange costume. He got his servant sed up in fantastic attire, and his dog would have torn him to es had not proper precautions been taken. When the dog, ever, had been operated upon, and the experiment was repeat- he remained perfectly calm, even when the servant stepped e close to him, though the animal was by no means blind.

t is not difficult to detect in all these experiments an affection ome faculty which, when excited, causes timidity. What the

element of that faculty is I can not tell, but in its actions it is concerned with the emotion of fear.

Prof. Ferrier found, when experimenting on dogs and other animals on a portion of brain marked 5 (Fig. 1), which corresponds to "the ascending frontal convolution at the base of the superior frontal" in the human brain, elevation of shoulder and extension forward of the opposite fore-limb, or flexion of the forearm and paw.

Now, according to Darwin, raising of the shoulders—sometimes accompanied by extension of the arms—is a sign of non-resistance. He inquires, page 271:

"Why men in all parts of the world when they feel—whether or not they wish to show this feeling—that they can not or will not do something, or will not resist something if done by another, shrug their shoulders, at the same time often bending in their elbows, showing the palms of their hands with extended fingers, often throwing their heads a little on one side, raising their eyebrows, and opening their mouths."

On page 270 he says: "Shrugging the shoulders likewise expresses patience or the absence of any intention to resist. Hence the muscles which raise the shoulders are sometimes called, as I have been informed by an artist, the patience muscles."

Mantegazza (La Physionomie et les Sentiments, page 113, etc.) dwells on the importance of the movements of the arm in the act of submission, devotion, and veneration. Darwin doubted whether the kneeling posture, with the hands upturned and palms joined, is an innate expression of devotion, but rather thought this posture a sign of submission. Mantegazza differs from Darwin; he holds that it is from the habit we have from our childhood to join our hands for prayer, that we employ the gesture when appealing to human beings, who can do us either much good or great harm. He thinks this gesture is innate and not acquired. He questioned many artists, and gives as the result distinct rules, showing the importance which the position of hand and arm play in the expression of veneration and devotion.

We know, then, that the raising of the shoulders, together with the bending of the arms and hands, are concerned in the physical expression of submission or non-resistance.

The old phrenologists located in this region their organ of "veneration" (*e*, Fig. 2) which is to give an impulse to devotion and worship. Combe (System of Phrenology, page 212) says: "Children who are prone to rebellion, regardless of authority, and little attentive to command, will generally be found to have this organ deficient. Veneration leads to deference for superiors in rank as well as in years, and prompts to the reverence of authority."

Large "veneration," say the phrenologists, produces an instinctive feeling of respect; a defect of "veneration" has the effect of diminishing the reverence for power. Dr. Spurzheim called it the emotion of reverence and respect.

We see again the strong relation between the old phrenology and the results of the experiments of modern phrenology. On the one hand, I have shown you that the effect produced by Ferrier's faradization is the natural language of a feeling of non-resistance; on the other, that observations of Gall resulted in ascribing to this portion of brain the seat of the emotion of respect and reverence. Of course, respectful people do not resist authority.

Gall appears to me to have been aware of the importance that the study of the physical expression of our emotions and thoughts will play some day, and to have been expecting that this study of the physical parallel to our mental operations will furnish new evidence for his or any other system, built upon the parallelism of brain and mind. He devotes a chapter to pathognomy, of which the following extract may prove interesting: "This art is founded on Nature herself; for it is Nature that prompts all the gestures, the attitudes, the movements, finally the whole mimicry, by which men and animals express all their feelings and ideas. Pathognomy has its fixed and immutable laws, whether we appy it to man or to animals, so long as the question relates to the same feelings and the same ideas. Pathognomy is the universal language of all nations and of all animals. There is no beast or man who does not learn it; there is no beast or man who does not understand it. It accompanies language and strengthens its expressions; it supplies the defects of articulate language. Words may be ambiguous, but pathognomy never is so. What would become of engraving, painting, sculpture, the comic art, eloquence, poetry, if the expression of the sentiments and ideas were not subjected to immutable laws? What means would they have in their power to paint modesty, prudence, fear, despair, baseness, joy, anger, contempt, pride or devotion? Where is the animal or man who takes time to deliberate on the manner in which he would make his feelings and his ideas understood by others? Even at the moment when the feelings and the ideas arise, they are written on the exterior in characters discernible by all the world. It is certain, therefore, that the feelings, ideas, affections, and passions are manifested by suitable expression according to determinate and invariable laws."

Gall noted the physical expression of our emotions, though he could give us no explanation of its cause.

With the assistance of Hitzig, Fritsch, and Ferrier's experiments on the one hand, and Gratiolet, Piderit, Darwin, and Man-

tegazza's observations on the other, I have endeavored to show you to night: (1) the reason why certain muscles and limbs are called into action by certain feelings and emotions; and (2) how to demonstrate centers of ideation by comparing the physiological experiments with pathognomy.

My work is, however, not complete: for, first of all, I have not attempted to find the elements of those faculties which I located; secondly, we must take into consideration that mind, like brain, is very complicated, and, even had philosophers ever agreed as to its elements, we know from experience that an emotion seldom acts singly.

Like all novelties, my paper will create some opposition, but I do not fear criticism: I only ask for a re-examination of Gall's work, which I believe has been rejected without due consideration.

DISCUSSION.

Dr. Beddoe thought that, although phrenologists had erected an edifice of straw and rubbish on the foundations laid by Gall and Spurzheim, these last had been men of considerable power and acuteness, whose observations ought not to be neglected in any new attempts at the localization of faculty.

Dr. Ferrier remarked that, as the relations between brain and mind were still in many respects very obscure, he cordially welcomed any attempt to throw light on the problem. So far the physiological or objective functions of certain cerebral regions had been determined, but the question was, What are the correlations between the objective and the subjective or psychological aspects of these same regions? As the brain was composed of sensory and motor substrata, and as the brain was the organ of ideation, therefore ideation was the functioning of centers whose objective functions were motor and sensory. That there was a relation between the development of certain regions and certain motor and sensory faculties and capacities was undoubted, and was amply proved by the facts of comparative anatomy and physiology, normal and morbid; but whether any particular center could be taken as the index of any particular intellectual faculty or peculiarity was a totally different matter, for the same center might be called into activity in connection with unnamable mental states. Of which, then, would it be the index? Mr. Hollander's speculations in reference to so-called phrenological doctrines were ingenious; but what we wanted was evidence founded on careful investigation according to strictly scientific methods, serving to indicate a relation between the development of particular centers and special mental faculties, aptitudes, or peculiarities. At present he did not think that there was any such worthy of consideration, beyond the general indications above mentioned.

But the subject was one which was worthy of careful study, and a scientific phrenology might one day become possible.

Mr. Wakefield said that, as men's minds undoubtedly differed from each other in their natural characteristics, so, it might be presumed, did also the physical organs through which mind manifested itself. Was it possible to detect these differences? Were there, also, localized centers of action corresponding to certain faculties or powers of the mind? This was the problem for solution and demonstration. Some facts had come under his observation which led him to think that the solution was not hopeless; but the advance made in this department of knowledge as to the true relation of mind and body was but slow and uncertain.

Mr. G. Bertin remarked that it had been ascertained that the faculty of sight was localized in a convolution of the posterior part of the brain, and as we know that the faculty of speech is localized in the third left frontal convolution, it would seem that modern discoveries disprove the assumptions of the phrenologists. One great mistake of their system is to attribute the same faculties to the two lobes of the brain, a fact disproved by the localization of the faculty of speech on the left side. Another thing lost sight of is, that the examination of the head could only show the development of the surface of the brain, while we have no means to detect its inner development. Nor must we forget that the skull does not change after a certain age, though faculties may be still developing. Another mistake of phrenologists is to localize faculties too much; if phrenology is to become a science, broader lines will have to be followed, and Mr. Hollander's careful researches will do much to further this object.

Mr. Hollander, in reply, observed that nobody disputes the fact that there are brain-centers for ideation; the question is only as to their localization. But as the objective side—i. e., the physical correlative of mental manifestation—has been in many cases successfully established, there remains but the demonstration of the subjective side. How far the speaker had succeeded in this may be judged when the paper is read in type. So far he had not excited opposition. But now comes the coincidence that some of Prof. Ferrier's researches, especially on the gustatory center, confirm the early phrenological observations long ago rejected. By careful examination and a thorough study of Gall's works the speaker found that there was a sound basis to his system. Gall had extraordinary powers of observation, and was an expert in comparative anatomy. He noticed the resemblance between the skulls of murderers and the skulls of carnivorous animals; the predominance of the temporal lobe struck him, and both Prof. Benedict and Lombroso—the authorities on criminal anthropology—testify as to its correctness. Gall, in the same manner, noticed

peculiarities in the heads of actors, poets, musicians, etc. He reasoned that there must be in the case of murderers an organ giving an impulse to destroy or kill ("destructiveness"), in the case of mimics an organ giving an impulse to imitate ("organ of imitation"), etc. Now, these deductions are open to criticism, but the original observations are beyond dispute. There are no two characters alike, neither are there two skulls alike. The question in both cases is, how to measure the differences. There is no instrument for the measurement of those "ups and downs," protuberances and depressions of the living head. Between the skull of a Goethe and that of a murderer there are innumerable varieties. As we are able to distinguish the two extremes, why should we not succeed in demonstrating the intermediate stages? Gall's system was rejected at its first appearance, because it threatened to upset familiar notions about the liberty of the will, about special creation, and supernatural religion. This was the first obstacle, and very few men, even nowadays, care to risk the danger of opposing popular opinion. The author had attempted a revival of Gall's system, more scientific and appealing to the learned only. He hoped that it would be received without prejudice.

A QUEER PET.

By ELIZABETH W. BELLAMY.

ONCE, for ten summer days, I had the pleasure of entertaining a strange and most interesting guest, known among the learned as the *Mantis religiosa;* but the more familiar appellation of devil's-riding-horse, by which he is designated amid his native haunts, seems so appropriate to his demoniacal oddity that the creature might be recognized thereby on sight, without description. He looks much more like a nag for an imp of the Inferno than like a locust at prayer, despite the attitude as of supplication assumed when about to snap up an unwary fly.

I captured my specimen upon the stalk of a common geranium, to the pale-green color of which the hue of his long, slim, grotesque body so closely approximated that it was by the merest chance I espied him. Owing to this accommodation of tint—in summer, like the grass and plants amid which he seeks his prey, and, in autumn, like the twigs and branches whereon he alights—the praying mantis, though by no means a rarity in the fields and gardens of the South, commonly escapes all eyes save the sharpest. My prize was stalking his prey when I espied him. Nothing can be stiller than the *Mantis religiosa* when he is waiting to spring upon his victim; and at that propitious moment, armed

with a tumbler in one hand and a palmetto fan in the other, I made him my captive. I might have taken him with my fingers easily; but, though I do not believe, as the negroes do, that the bite of the devil's-riding-horse is "bad luck," or that this insect will "curse with blindness" by spitting in its captor's eyes if it can, I have a horror of the creature, and I prefer not to touch it.

FIG. 1.—MANTIS RELIGIOSA.

By way of introduction to those who do not know the *Mantis religiosa*, I would explain that he is classed with the *Orthoptera*, whereby is declared his kinship with the crickets, locusts, roaches, and grasshoppers; yet he is not cheery like the cricket, nor destructive like the locust, nor loathsome like the roach, nor vivacious like the

"Gay little vaulter in the sunny grass."

Nor does he resemble any one of these in personal appearance. Entomologically he is described in an array of big words which say but little for the particular specimen that amused my midsummer idleness. It is not as an entymologist, therefore, that I would portray my queer pet.

To the non-entomological intelligence, then, my captive appeared a pale, yellow-green, miniature *demon*, about two inches in length, the most of whose body, so to speak, had run to neck. About midway of this "neck"—or *pro-thorax*, to quote the entomologists—were attached a pair of "arms"—*antennæ*—with joints like "elbows." Below these joints the arms were divided and serrated, like the claws of a crab. Atop of the long neck the head was set transversely, like the upper portion of the letter T. An extremely flexible joint united this peculiar head to the rigid neck, and enabled the creature to look in all directions, out of a pair of extraordinarily intelligent and watchful eyes, that protruded from each "end" of the head. The mouth was very large, but, in spite of the powerful jaws, there was no expression of ferocity in that rather formidable feature. In normal condition the body proper, which is perceptibly shorter than the neck—so called—should be furnished with four slender, jointed legs, about an inch in extended length; but when under glass my prisoner was seen to be minus the right hind-leg. This deficiency, however, did not appear to interfere in the least with his activity, for he scrambled about his glass cell with a frantic speed that proved five legs as good as six in his case; of course, the two raptorial "arms" count as legs when it comes to locomotion.

By way of beginning my study of his character, I dangled a shoe-button first on one side and then on the other of his prison-

house, sometimes at the top and sometimes at the bottom of the glass; and it was then that I discovered the wonder of the tiny creature's eyes, the alertness of his intelligence, the extraordinary flexibility of the minute joint upon which the head is made to turn. He was not at all alarmed by the dangling black button, which he evidently mistook for a particularly choice dinner; but he was plainly puzzled, and finally distressed, by his inability to attain possession of this alluring dainty, seemingly within his very grasp.

So long as the button was in his sight, his whole being was absorbed in the effort to possess it; but, that object removed from his vision, he made the surface of the glass his study, feeling it with his thread-like tongue, and stretching out his anterior, raptorial feet, with an evident air of inquiry, along the transparent walls that shut him in so incomprehensibly.

Of course, the captive could not long remain in such a prison, and at this juncture a small boy came to the rescue. When the devil's-riding-horse is a subject of study, the small boy is an invaluable coadjutor; he quickly becomes expert as a purveyor of delicacies in the shape of living insects, for dead ones the dainty mantis will not deign to accept. The small boy, in this instance, perceiving at once the value of my captive, and the inadequacy of his lodging, forthwith provided a discarded fly-trap of wire gauze, cylindrical in form, six inches in diameter, and about nine inches in height, surmounted by a top of tin. The lack of a fixed flooring was supplied by a bit of cardboard.

The devil's-riding-horse was manifestly pleased with his transference to his more spacious abode, and he looked about him with a very comical air of studious observation. The wire gauze offered no more obstacle to his locomotion than did the glass, but he was plainly puzzled over the difference between the walls of this prison-house and those of the one he had left: for a little while he seemed to be weighing the problem intently, putting out a cautious claw for inquiry, and turning his head with an expression of deep attention from side to side, and pausing every now and then, in his upward course, to examine this strange new surface.

The first meal we offered our fantastic guest was a dead fly, but this he disdained in any way to notice; though he was repeatedly shaken to the bottom of the cage where the dead fly lay, he refused even to see it. Thereafter our fastidious captive had his meals served to him *au naturel*. The living fly was simply turned loose in the cage, and instantly the devil's-riding-horse was on the alert: warily he crept up the sides of the cage, settled himself in a position to spring, and then the fly would move, and the slow, laborious work of creeping upon his prey had all to be

done over again. But the patience of the devil's-riding-horse in pursuit of a dinner is inexhaustible, his perseverance indefatigable, and sooner or later the fly was inevitably his: with a snap like a steel trap, he clasped his victim, and, settling upon his haunches, he stripped off the gauzy wings—but at this point I fled. The small boy, however, had a stouter heart, and presently he announced that the meal was over; the devil's-riding-horse had devoured the fly, every atom, and was *licking his claws!*

We had a good magnifying glass wherewith to pursue our study of the prisoner, but it was easy enough to discern all his movements, his very expression, with the naked eye. Every one has seen flies go through the performance children call "washing its face," a sight so familiar that we fail to be impressed by it. In the devil's-riding-horse this is a most amusing exhibition. Our specimen would thrust out his filament of a tongue, carefully lick his serrated claws, examine them closely, scratch the back of his head which he twisted from side to side, rub one jaw and then the other, and turn and look at us out of those strange eyes of his, as if to rebuke our impertinent staring. Not infrequently he would end the performance with a mighty yawn—inaudible, of course—and scamper away, as far as his limits would allow. His bearing altogether was calculated to impress one with the idea that he entertained a serene contempt for the whole human family.

FIG. 2.—MANTIS RELIGIOSA, WITH HEAD RAISED.

Apparently he did not object to his imprisonment, for he showed no disposition to escape when, time and again, the opportunity was offered him; and except when a fly was introduced to his consideration, he usually remained motionless against the side of his cage, as often as not with his head downward. He never, of his own accord, betook himself to the bottom, not even in pursuit of his prey, and he finally came to prefer the tin top of the cage—possibly on account of the shade it afforded—clinging there like a fly to the ceiling. If we inverted the cage, he instantly crawled upward and clung to the bit of cardboard that did duty for a top. Once, when one of his claws was accidentally caught

between the cardboard and the tin rim of his cage, he dropped down and stood shaking the wounded member, just as a boy shakes his hand when he has caught his finger in a door; then he licked his bruises, holding up the tiny claw and carefully examining it.

Early on the morning of the seventh day after his capture, his friend the small boy announced that the devil's-riding-horse had shed his skin, and had grown to twice his former size! But this was not strictly accurate. The mantis had indeed shed his skin, which lay in the bottom of his cage like a shrunken and discarded garment, or rather like a sort of abandoned self, so perfect was every feature of the outgrown mask; but the devil's-riding-horse, though wonderfully expanded in his new estate, was not *twice* as large as we had known him the day before. In other respects, also, he showed a difference: he was beginning to change color; a small brown spot was visible on the back of his folded wings, and in two days more he was as brown as his cage—as brown as any twig he might elect, in his coming freedom, to alight upon. But, strangest change of all, *the missing right hind-leg was there*, very much shorter than its fellow; and, whereas our devil's-riding-horse had never heretofore seemed to be conscious of his deficiency, he now went lame! However, for yet another marvel, in a few days more, that tardy leg was as well developed as the others.

About this time we discovered that something ailed our prisoner. He clung more persistently than ever to the top of his cage, and could hardly be induced to stir, even for a fly. Still, he would at his leisure make a dash at every insect offered him; but, though he captured and killed his prey, he did not devour it. Therefore, lest he should die on our hands, we decided to release him. For this purpose we took him to the same flower-stand where he had been captured, and on a bare shelf, exposed to the blazing noon, we reversed the fly-trap, leaving it open to the sky. The captive was, as usual, clinging to the tin top of his prison-house, but, the instant he perceived himself at the abhorred bottom, he began to crawl up the side of the cage.

Now, we had expected that the release of this prisoner would be a very tame affair of ready wings; but there was a dramatic surprise in store for us. When we looked to see our mantis "spread his sheeny vans for flight," he paused on the tin rim that bound the wire gauze, and lifting that queer head of his until it almost lay back on his neck, he gazed up at the sky; turning slowly from side to side, he took a long survey of the heavens, his vision in no way troubled, it would seem, by the blinding light. After several seconds of this sky-gazing, he shifted his position slightly, and peered down at the depth from which he had ascended; then he looked at the sky again, and again he peered at

the bottom of his cage. Evidently he was puzzled; heretofore, when he climbed those walls, he had invariably found a rest at top—tin at one end and cardboard at the other; but this vast expanse of light was a marvel to be pondered and not too rashly accepted. That mantis never did fly; he crawled around the edge of the cage at last to a spot where it touched a higher shelf of the flower-stand, and, as if he had just discovered that he was a prisoner no longer, scrambled with more haste than discretion up to the next shelf, where a huge black spider, whose lair was just under the verge of the shelf, pounced upon him so suddenly that retreat was impossible. The mantis was taken completely by surprise, and the start he gave was so violent that but for the spider's swift, encompassing arms, he must have fallen backward off the shelf. Thereupon ensued a terrific struggle; the devil's-riding-horse made a brave resistance, but the spider would have proved too much for him, so his late jailer, armed with a broom-straw, separated the combatants. The spider retired to the shadow of the shelf, and the mantis, climbing upon the leaves of a mespilus-tree that reached against the farther side of the flower-stand, disappeared from our ken forever.

THE USES OF ANIMAL COLOR.*

By EDWARD B. POULTON, M. A., F. R. S.

COLOR, as such, is not necessarily of any value to an organism. Organic substances frequently possess a chemical and physical structure which causes certain light-waves to be absorbed; or, the elements of tissues may be so arranged that light is scattered, or interference colors are produced. Thus blood is red, fat is white, and the external surface of the air-bladder in certain fishes has a metallic luster, like silver. In such cases there is no reason why we should inquire as to the use or meaning of the color in the animal economy; the color, as such, has no more meaning than it has in a crystal of sulphate of copper or iron. Such colors are the incidental results of chemical or physical structure, which is valuable to the organism on its own account. This argument will be still further enforced if we remember that the colors in question are, strictly speaking, not colors at all. Blood and fat are so constituted that they will be red and white, respectively, in the presence of light, but they can not be said to possess these colors in their normal position, buried beneath the opaque surface of an animal.

* From advance sheets of The Colors of Animals, by Edward B. Poulton, M. A., F. R. S. International Scientific Series, No. LXVII. In press of D. Appleton & Co.

The existence of non-significant colors is, nevertheless, most important, for they form the material out of which natural or sexual selection can create significant colors. Thus the color of blood may be made use of for "complexion," while fat may be employed to produce white markings, as in certain insect larvæ. The yellow, brown, and red fatty matters of the connective tissue are accumulated beneath the skin in patches, so as to produce patterns.

All animal color must have been originally non-significant, for, although selective agencies have found manifold uses for color, this fact can never have accounted for its first appearance. It has, however, been shown that this first appearance presents no difficulty, for color is always liable to occur as an incidental result. This is even true of the various substances which seem to be specially set apart for the production of color in animals; for pigments occur abundantly in the internal organs and tissues of many forms. The brilliant colors of some of the lower organisms are probably also non-significant. In all higher animals, however, the colors on the surface of the body have been significant for a vast period of time, so that their amount, their arrangement in patterns, their varying tints, and their relation to the different parts of the body, have all been determined by natural selection through innumerable generations. Because the origin of all pigments is to be found in the incidental result of the chemical and physical nature of organic compounds, it by no means follows that incidental or non-significant colors would have appeared at all on the surface of most animals. And we find as a matter of fact that such colors tend to disappear altogether, directly they cease to be useful, as in cave-dwelling animals. On the other hand, the non-significant color of blood or of fat would persist undiminished in such forms.

Just as natural selection may develop an appearance which harmonizes with the surroundings, out of the material provided by non-significant color, the same agency may lead to the disappearance of the latter when it impedes the success of an animal in the struggle for existence. Thus the red color of blood has disappeared in certain transparent fishes, which are thereby concealed from their enemies. Among the manifold possible variations of nature is that of a fish with colorless blood, which can, nevertheless, efficiently perform all the duties of this fluid. While such a variation would be no advantage to the great majority of vertebrates, it would be very beneficial to a fish which was already difficult to detect on the surface of the ocean on account of its transparency.

Colors may be useful in many ways, and are therefore always liable to be turned to account in one direction or another. They

may be of direct physiological value to the organism, or may assist in the struggle for existence by deluding other species, or by aiding the individuals of the same species, or they may be intimately connected with courtship.

The color of chlorophyl, which causes the green appearance of vegetation, must be intimately connected with the important changes which take place in this substance in the presence of light. It is well known that under these circumstances carbon dioxide (popularly called "carbonic acid") can be split up, and its carbon made to unite with the elements of water, forming organic substance. Although this process has been much studied, it is still very imperfectly understood. It is clear, however, that the color of chlorophyl, involving the special absorption of certain light-waves, has some direct bearing upon the changes which occur.

No equally clear instance has been proved to occur in the animal kingdom, except in those few forms which resemble plants in possessing chlorophyl. Dr. Hickson, however, believes that among corals "the most widely distributed colors will eventually be proved to be allied to chlorophyl, . . . and perform a very similar if not precisely identical physiological function." It is much to be desired that this interesting suggestion, which Dr. Hickson supports by many arguments, may be thoroughly tested as soon as possible.*

In the very common association of colored substances with the important function of respiration, it is clear that the color is not more than incidental; while the fish with transparent blood shows that color is not indispensable for the due performance of the function. Pigment is, however, of direct importance for vision; it is always present in the eyes of animals, except in the case of albinos, and it is said that even they possess the essential visual pigment associated with the termination of the optic nerve (retinal purple).

The difference between the physiological importance of color in animals and plants is well shown by the fact that a true albino variety (not merely a variegated example) of a green plant could not live for any length of time.

There are, however, certain cases among animals in which it is extremely probable that color is of direct physiological value. It is well known that dark colors readily absorb radiant heat, while light colors do so with difficulty. For this reason black clothes are most trying, and white most comfortable, in the hottest weather. Conversely, a dark surface readily parts with heat by radiation, while a white surface retains heat far more effectually.

A few writers had suggested that these principles may explain

* A Naturalist in North Celebes (Hickson, 1889), pp. 149–151.

the colors of certain animals, but the question was first fully entered upon in Lord Walsingham's presidential address to the Yorkshire Naturalists' Union in 1885.* The predominance of *dark* varieties of insects and *white* varieties of birds and mammals in northern latitudes is connected with these facts. "Birds and animals living through the winter naturally require to retain in their bodies a sufficient amount of heat to enable them to maintain their existence, with unreduced vitality, against the severities of the climate. Insects, on the contrary, require *rapidly to take advantage* of transient gleams of sunshine during the short summer season, and may be content to sink into a dormant condition so soon as they have secured the reproduction of their species; only to be revived in some instances by a return of exceptionally favorable conditions."

It would be fatal for the temperature of one of the higher vertebrates to sink a few degrees below the normal, except in the case of certain species, such as the dormouse, etc., which have the power of hibernating in a dormant condition; such animals were once called "warm-blooded," but are now more correctly termed "homothermic," because it is the *constancy* of the temperature which is so important, and which must be maintained whether the surrounding medium be colder or warmer than themselves. Other animals with an inconstant temperature are now correctly called "poikilothermic" rather than "cold-blooded."

Lord Walsingham's conclusions appear to be supported by the fact that young dark-colored caterpillars, like those of the emperor moth (*Saturnia carpini*), or tortoise-shell butterfly (*Vanessa urticæ*), seek the light side of a glass cylinder, and always change their position when the cylinder is turned round. The question needs further investigation, and much might be learned by interposing various screens between such larvæ and the light, thus cutting off different sets of light-waves.

The most important support to the hypothesis is found in an experiment made by Lord Walsingham, in which several *Lepidoptera* of different colors were placed on a surface of snow exposed to bright sunshine; in half an hour the snow beneath the darker insects showed distinct signs of melting, but no effects were seen beneath the others. The differences were further brought out in the course of two hours, when the darkest insect of the lot, a black geometer, the chimney-sweeper (*Odezia chærophyllata*), "had decidedly won the downward race among them."

It is therefore certain that the absorption of radiant heat is favored by the dark colors of northern insects, and it is in every way probable that they are benefited by the warmth received in

* See Entomological Transactions of the Union for 1885.

this way. We can not, however, as yet assert that such dark colors are not also advantageous for concealment or some other purpose.

The white appearance of arctic birds and mammals must be advantageous for concealment in a region so largely covered with snow, but it is very probable that advantage is also secured by checking the loss of heat through radiation.

Thus Lord Walsingham's experiments and conclusions seem to prove that colors are sometimes of direct physiological value to animals, although a great deal more work must be done before we can safely estimate the proportion which this advantage bears to others also conferred by the same colors.

By far the most wide-spread use of color is to assist an animal in escaping from its enemies or in capturing its prey; the former is *protective*, the latter *aggressive*. It is probable that these were the first uses to which non-significant colors were put. The resemblances are of various kinds; the commonest cases are those of simple concealment. The animal passes undetected by resembling some common object which is of no interest to its enemies or prey respectively, or by harmonizing with the general effect of its surroundings; the former is *special*, the latter *general resemblance*, and both may be *protective* or *aggressive*. Among the most interesting *special aggressive resemblances* are the cases of *alluring coloring*, in which the animal, or some part of it, resembles an object which is attractive to its prey.

Mimicry is in reality a very important section of *special resemblance*. The animal gains advantage by a superficial resemblance to some other, and generally very different, species which is well known and dreaded because of some unpleasant quality, such as a sting or an offensive taste or smell, etc., or it may even be protected from the animal it resembles: this is *protective mimicry*. When, however, the animal resembles another so as to be able to injure the latter or some other form which accompanies it or is not afraid of it, the *mimicry* is *aggressive*. . . .

When an animal possesses an unpleasant attribute, it is often to its advantage to advertise the fact as publicly as possible. In this way it escapes a great deal of experimental "tasting." The conspicuous patterns and strongly contrasted colors which serve as the signal of danger or inedibility are known as *warning colors*. In other cases such colors or markings enable individuals of the same species easily to follow those in front to a place of safety, or assist them in keeping together when safety depends upon numbers. It is these *warning colors* which are nearly always the objects of *protective mimicry*.

Finally, in the highest animals, the vertebrata and many of the most specialized invertebrate groups, we have some evidence for the existence of an æsthetic sense. Darwin believed that this

sense was brought into play in courtship, and that colors and pattern have been gradually modified by the preference of the females for the most beautiful males; he believed that such *sexual selection* accounts for many of the most beautiful features possessed by animals, viz., those which are especially displayed during courtship.

THUNDER-STORMS.

By ROBERT H. SCOTT.

THUNDER-STORMS naturally attract universal attention when they occur, and it may perhaps be of interest to point out some particulars that have been ascertained about them.

The most obvious facts are that a heavy cloud passes over the observer, and that from it lightning appears, followed, after a greater or less interval, by thunder; and that usually heavy rain or hail falls from the cloud. The damage wrought by these occurrences, whether by lightning-strokes or by the hail, is so serious that, in countries especially liable to such visitations, hail insurance forms an important item in the farmer's calculations. In many countries such insurance is in the hands of the Government, and accordingly statistics as to the amount of losses are to be obtained; whereas where insurance is in the hands of private companies, information as to the expenditure of these companies is naturally not published.

As regards the liability of certain districts to suffer damage from thunder-storms, it has been maintained by several authorities that these visitations are steadily increasing in frequency. A most elaborate inquiry into the records of such occurrences was printed in the Journal of the Statistical Office of Berlin for 1886. From this it appears that the evidence indicated no general increase in the frequency of lightning-strokes, but, on the contrary, rather a decrease. Houses with soft or, in other words, thatched roofs are struck about seven or eight times more frequently than ordinary slated dwelling-houses. Houses in towns are much less frequently affected than those in the country.

The geological character of the soil has a very great influence on the risk. If this for a limestone soil be taken as one, that for a sandy soil is nine, and for swampy land twenty-two. As regards the different classes of trees, if the risk to a beech be taken as one, that to a conifer (fir or spruce) is fifteen, to an oak fifty-four, and to other deciduous trees forty. Another investigator accounts for the comparative immunity of the beech by the fact that its leaves are edged with short hairs, which allow the electricity collected in the leaves to escape quietly.

As to the actual origin of atmospheric electricity, authorities

are not at all agreed, and the observations made on its phenomena (made at different stations) do not accord in a satisfactory manner. In fact, it appears as if the indications of the instruments are due to local causes, so that they do not lend themselves to any useful generalizations. When a thunder-storm is actually raging in the neighborhood of a station, the indications of electrometers thereat are most erratic and violent, but it can not be said that any electrometer enables us to perceive the approach of a storm one whit earlier than we are able to do by careful watching of the clouds. As regards forecasting thunder-storms, this can be done in a general sort of way; but it is not practicable to predict which villages or parishes, or even counties, will be visited. When the daily weather charts are drawn, if we find that there is an unevenness in the isobaric lines—that is, if these are wavy, or bulge out irregularly—we know that thunder-storms are likely to burst somewhere or other over the country, but that is all we can say. At each station the barometer is unsteady—the mercury moving up and down in the tube—during the actual continuance of the storm; but this oscillation of the mercurial column has nothing to do with the irregularity in the isobaric lines above mentioned. Forecasting these storms is, therefore, always an uncertain and a thankless task, for local success is rarely attained.

Among the earliest symptoms of the approach of a thunder-storm is the appearance on the western horizon of a line of *cumulus* ("wool-pack") clouds, exhibiting a peculiar turreted structure. I say on the western horizon, for most of our changes of weather come from that quarter, and it has been proved that thunder-storms, like wind-storms, advance over the country, generally, from some westerly point. This bank of clouds moves on, and over it appear first streamers and then sheets of lighter upper cloud—*cirrus*, or "mare's-tail"—which spread over the sky with extreme rapidity. The heavy cloud mass comes up under this film, and it is a general observation that no electrical explosion or downfall of rain ever takes place from a cloud unless streamers of *cirrus*, emanating from its upper surface, are visible when the cloud is looked at sideways from a distance.

Thunder-storms are generally accompanied by falls of hail as well as rain, and these hailstones assume the form of lumps of ice —some even as large as hens' eggs, and weighing several ounces, having been known to fall. The stories of masses of hailstones, weighing many pounds, having been found after storms, are explained by the fact that the hailstones, after they have fallen, may have frozen to each other and formed a solid lump on the ground. Large hailstones are composed of alternate layers of clear crystalline and white porous ice, and many of them consist of an aggregate of smaller hailstones which have attached them-

selves to one stone as a nucleus, and then the mass so formed has received external coatings of ice. The compound structure of such stones becomes manifested when the mass gradually thaws. In some cases these stones are coated with crystals of ice in six-sided prisms and pyramids, as perfectly formed as the specimens of quartz or calc-spar crystals which are to be seen in mineral collections. It is very hard to believe that such beautifully formed crystals as these can be the product of any instantaneous process of formation.

It is these heavy blocks of ice which do the greatest amount of damage, as naturally a lump, weighing even an ounce, is a formidable missile when it falls from a height of even a thousand feet. When these falls are about to take place, observers have reported that a peculiar rattling sound is heard in the atmosphere, evidently from collisions between these stones striking one another in their fall. A very careful observer, who was overtaken by one of these falls in the Caucasus, near Tiflis, states that it occurred immediately after an ordinary hail-shower, and that he could see the successive showers marching over the country, and noticed that, between the last edge of the falling hail and the front edge of the falling ice-blocks, there was a distinct break, through which he could see the sun shining on the hills in the background. It was on this particular occasion that the best specimens of crystal-bespangled hailstones have been recorded and sketched, but others have been reported from Natal, and quite recently from Philadelphia, October 1, 1869. When such a visitation of ice-lumps takes place, the entire crops of the district affected by it are destroyed. Such a storm passed over Richmond in August, 1879, and in five minutes some ten thousand pounds' worth of damage was done, principally to conservatories. Naturally, Kew Gardens were among the principal sufferers.

It is a problem as yet unsolved to account for the suspension in the atmosphere of such objects as these hailstones, which frequently weigh much over an ounce. A recent theory, which seems to carry some probability with it, supposes that in the heart of every hail-cloud there is a whirlwind, or what is usually but erroneously termed a "tornado." It is well known that such disturbances exert a prodigious lifting power, raising heavy objects, such as carts, house-roofs, and even trees, and transporting them to considerable distances. The theory is, that when a drop of water in such a cloud is congealed it is carried round and round in the vortex and lifted up, more moisture being condensed and frozen upon it at each gyration, until at last it is thrown out and falls. This would account for the alternate layers of which I have already spoken, but will not account for the formation of crystals, a growth which usually requires a considerable time.

Thunder-storms have been scientifically studied in various countries, and the broad fact has been elicited that they travel over the earth's surface like wind-storms, but at a higher velocity. To give an idea of this, I may quote some statements made before the Royal Meteorological Society last June, in relation to the storm of the 2d of that month. This storm progressed from Wiltshire to Edinburgh, over a distance of four hundred miles, at a nearly uniform speed, the rate of travel being about fifty miles an hour. This is an unusually rapid rate of advance for a wind-storm over these islands. I am not speaking of the velocity of the wind in the storm, but of the velocity of the storm system as a whole. In this storm many of the hailstones which were collected weighed over an ounce. Some at Docking, near King's Lynn, were said to be three inches in diameter, and to weigh three and a half ounces. One was weighed at Barden Mill, near Tunbridge Wells, and was said to turn the scale at half a pound. As regards the incessant character of the lightning in London, one observer at Highgate counted twelve hundred and forty-four displays during the two hours ending at 11.10 P. M., giving an average of over ten per minute. Another observer, at Westgate-on-Sea, gave a much higher figure for frequency; his attempt to count breaking down at the very high number of one hundred and thirty-one per minute.

Thunder-storms are much more frequent in low latitudes than in high. In some tropical countries they are said to occur regularly every afternoon. At Rio the story was that at certain seasons, in issuing invitations to afternoon parties, it was usual to specify whether guests were to assemble before or after the thunder-storm. In Abyssinia, D'Abbadie gives, as the average of four years, 410·6 as the annual number of these storms. Many of these, however, consisted of only one or two flashes of lightning. It was formerly believed that such storms never were noticed in the arctic regions, but this is not the case, for one was experienced at Bell Sound, Spitzbergen, in 78° north latitude, in August, 1873; and a succession of thunder-storms was reported for several days in July, 1870, on the west coast of Nova Zembla. At any rate, in such high latitudes they are very rare.

Thunder-storms are generally divided into two groups—heat thunder-storms and cyclonic thunder-storms. The former are the summer type, while the latter occur principally in autumn and winter. We may also say that the former are essentially continental, while the latter are characteristic of the ocean or island climate. In Iceland all the thunder-storms are of this latter type, and occur in winter. The same conditions show themselves on the British Atlantic coasts, where there is a decided maximum of frequency of such storms in winter, even in the latitude of the south-

west of Ireland, at Valencia. These circumstances are accounted for by the fact that thunder-storms are always associated with great differences of temperature in adjacent masses of air. Such conditions are most likely to occur in hot climates, where the soil gets excessively heated in the daytime, while the air at some distance above it is cool. In cold climates they occur in winter, where a shift of wind from southwest to northwest is sometimes accompanied by a sudden fall of temperature of 15° or even 20°.

We of the British Islands owe our comparative immunity from thunder-storms to our damp climate. The fact is well known that it is comparatively difficult to perform any electrical experiments in these islands, and that all apparatus must be kept constantly in front of a fire in order to prevent moisture being deposited on it. Accordingly, we must suppose that the electrical disturbances which would give rise to explosions and severe storms in France or Germany may pacify themselves comparatively quietly in our atmosphere, and at most only give rise to phenomena of a very moderate character.

I must now say something about the actual lightning flash, which is neither more nor less than a violent electric spark. Three different forms of lightning are generally admitted to exist: (1) The actual flash, or what is commonly called "forked lightning." (2) "Sheet lightning," which usually is the illumination of the sky by a lightning flash which takes place below the horizon. (3) "Globular lightning."

1. As to the term "*forked lightning*," the representations of it given by artists, which resemble the so-called thunderbolts placed in the hand of Jupiter, are quite absurd. The flash, when photographed, exhibits itself as a line which is continually changing its course, and is described as "intensely crooked" by a very careful observer. It never proceeds for a time in a straight line, and then, turning at a sharp angle, going on farther in an equally straight line, as is represented in pictures. The forking of it is very marked, and this occurs by side flashes passing off from the main track, and eventually losing themselves, like the ramifications of tree-roots. Occasionally the lightning appears to start from a point from which several flashes diverge in different directions.

2. "*Sheet Lightning.*"—Whenever a flash passes from cloud to cloud, or from cloud to earth, the light produced by it illuminates the sky in the neighborhood, and the more intense the flash, the more brilliant and extensive the illumination. At times sheet lightning has been proved to emanate from an ordinary storm distant more than a hundred miles from the point of observation. It is, however, maintained, and apparently with good reason, that occasionally lightning of the "sheet" type, such as what is called

'summer lightning," takes place without any thunder; so that, n such cases, no actual thunder-storm is in progress.

3. "*Globular Lightning.*"—This is a rare phenomenon, and one which no one has as yet been able to produce in the laboratory, whereas the phenomena of the two previous types are easily produced. The general description of the occurrence is that a luminous ball is seen, moving very slowly, not touching any object, and eventually breaking up with a violent explosion and the appearance of several flashes of ordinary lightning. It is reported that persons have gone out from a house into a street to follow such a ball and watch its movements, so that the occurrence must have lasted at least a number of seconds. Ordinary lightning, as is well known, is practically quite instantaneous. The size of the ball on different occasions has varied from that of an orange to that of a large glass lamp-globe, or even larger. Many physicists refuse to believe any accounts of this manifestation of the electrical discharge, but the reports of it are too numerous and circumstantial for us to consider them to be entirely baseless.

There is another way of classifying lightning flashes, and that is as to their color. The seven colors of the solar spectrum are well known, but the spectrum of the electric spark differs materially from the solar spectrum. It exhibits rays which extend far beyond the extreme violet of the solar spectrum. We see, therefore, that in the light of lightning a wide range of color is possible. If any of my readers have ever watched a storm carefully, they must have noted that some of the flashes were bluish, others reddish, etc. It is generally the blue tints which accompany the most destructive strokes.

Some attempts have been made to estimate the actual force exerted by a lightning flash. The late Mr. de la Rue constructed a magnificent electrical battery of many thousand cells. From experiments with this, the number of cells being raised to 15,000, and the "potential" of each being rather over one "volt," it was found that 9,700 "volts"—say 9,500 cells—were required to produce a discharge through one centimetre (·3937 inch). Starting from these data, the electro-motive force requisite to produce a flash of lightning one mile (63,360 inches) in length, at ordinary pressures, is 1,480,570,000 volts, practically given by a battery of fifteen hundred million cells.

A flash a mile in length is nothing very extraordinary, and it is therefore not to be wondered at that experiments to bring electricity down from the clouds are very dangerous, and have frequently had fatal results. Soon after Franklin, in the last century, had made his famous experiment with a kite, and proved that electricity existed in a thunder-cloud, natural philosophers generally began to imitate him. One of them in St. Petersburg, a

Prof. Richmann, arranged an apparatus to collect this electricity. On the first occasion of a storm he went to his laboratory to observe the effects. A ball of fire was seen to leap from the apparatus to his head, and he fell lifeless.

A flash of lightning really consists of a discharge between two objects, say two clouds, or a cloud and the earth, oppositely electrified, the charges on which suddenly combine, with the manifestation of light and heat. Lightning conductors are contrivances by which the electricity of the earth is allowed to escape quietly into the atmosphere, where it meets with electricity of the opposite character from the clouds, and the two neutralize each other quietly, without any explosive discharge, or, in other words, without lightning. I need not go back to the first principles of electrical science and explain why it is that electricity passes most easily through metals, and escapes with greater freedom from sharp points than from rounded knobs. Assuming these elementary facts, I may say that on any object, such as a house or other building, the electricity tends to accumulate itself on all projecting portions of the roof, etc., and especially on the highest points of it. The ideal complete lightning-rod system would call for a sharp-pointed copper rod erected at each of these projecting pinnacles, and rising above it, and would then connect all these separate points by copper rods, and eventually carry down a stout copper rod to the earth. Care must be taken that due attention is paid to certain main precautions: (1) The point of the conductor must be kept sharp; (2) the section of the conducting rod must be sufficient to allow the electricity to pass along it; (3) the rod must be perfectly continuous; and, lastly (4), the rod must be efficiently connected with the ground.

1. The sharpness of the point is insured by gilding it or coating it with some metal which resists oxidation.

2. As to the section of the rod, a bar half an inch in diameter is sufficient for all ordinary buildings. Bars are not usually employed, as it is difficult to bend them over cornices, etc.; accordingly, either wire ropes or tapes are taken. The wire ropes are more liable to corrosion from wet getting in between the strands than are tapes, so that the latter are generally preferred.

3. The continuity of the metallic connection from the highest point of the rod to the ground can only be secured by having as few joints as may be, and by making those joints as true and firm as possible by soldering. The joints should be examined from time to time, for it is often found, on examination of old conductors, that while the copper wire or tape is quite sound along its straight reaches, at the bends or joints corrosion has set in. As a chain is no stronger than its weakest link, a corroded conductor, such as has been described, is perfectly useless.

4. *The Earth Connection.*—It is not easy in all cases to insure that this is satisfactory. Electricity will not pass at all so easily into dry earth as into wet earth, and merely plunging the end of the rope or tape into wet earth is not sufficient. The conductor from the building should be soldered at its end to a large sheet of copper, say at least two square yards in area, buried in damp soil, or else soldered to the water or gas mains, so as to insure that a large surface of metal is in contact with damp earth.

Supposing that the whole system of protection against damage from lightning has been properly planned, the work should be carefully tested after its completion, because injury to it often occurs at the very last, owing to accidental causes, or to the carelessness of workmen. Conductors should also be examined from time to time, throughout their whole length, to make sure that all the joints are sound. Care should also be taken that the earth in which the terminating plate is buried is kept thoroughly moist. If any of these particulars be neglected, the conductor will be practically useless, and will afford no protection to the structure. —*Abridged from Longman's Magazine.*

SKETCH OF RUDOLPH KOENIG.

By Professor W. LE CONTE STEVENS.

IN examining the personal records of men who have contributed to the advancement of human knowledge, one of the features most frequently noticed is the necessity to meet adversity in early life. Perhaps it is but little less frequently the case that they are compelled throughout life to content themselves with a minimum of pecuniary reward for the mental work which meets due appreciation only after its final close. The thirst for discovery, the craving after truth, apart from all considerations of emolument, exist germinally in every young human being; but the rewards that the world gives for brain-work, other than what is directed toward the discovery of truth, are sufficient to determine most men and keep them occupied in fields other than scientific. Native bent, if fortified with force of character, finds its channel in time, whatever may be the accidents of childhood; and uncongenial occupation has been the lot of many who have used it as the basis of future renown.

Quite a number of those who have achieved distinction in physical science have, in early life, or throughout life, given a considerable share of attention to the mechanical details involved in constructing the instruments needed for investigation. Newton began in youth the making of machines, and his skill as a

practical optician was only less remarkable than his genius as a mathematician. Herschel practiced music as a profession, while giving all his spare time to the grinding of telescope mirrors and to observational astronomy. Ruhmkorff wandered to Paris as a boy of sixteen, and became a porter in the laboratory of a French physicist. In time his name became known wherever the induction coil is used, whether in the investigations of the physicist or in the operations of commercial electricity. Wheatstone adopted the vocation of a maker of musical instruments in preference to grinding Greek and Latin verses at school. This work he continued for many years, achieving world-wide distinction as an original investigator in acoustics, and afterward in optics and electricity.

Younger than Ruhmkorff and Wheatstone, but amply worthy of being classed with them, is RUDOLPH KOENIG, the most distinguished living inventor and mechanician in the domain of acoustics. He was born on the 26th of November, 1832, in Koenigsberg, Prussia. His father was teacher of mathematics and physics in the city gymnasium, where the son as pupil received the usual high-school training, corresponding in some particulars to the academic work in most American colleges. He exhibited much aptitude in physics as well as music; but, being compelled to depend upon his own resources, he went to Paris at the age of nineteen years, to devote himself to the construction of stringed instruments. Here he worked for several years under the direction of the celebrated violin-maker Vuillaume, but at the same time devoted such leisure as he could command to the study of mechanics and physics.

Quite naturally acoustics was the branch of physics which presented most attraction to the young mechanician, and in time it claimed his almost undivided allegiance. Meanwhile his success was such as to warrant him in undertaking business on his own account, so that in 1858 he fitted up a working place for the construction of acoustic apparatus, and in 1859 he issued his first catalogue, containing descriptions and illustrations of the various instruments made by him. Some of these were improvements upon instruments already in use, but many were new, the outcome of Koenig's own ingenuity. This catalogue formed the basis of the subsequent expansions which appeared in 1865, 1873, 1882, and 1889. The last is a volume of one hundred pages, with descriptions of two hundred and seventy-two instruments, in French, English, and German, and including probably everything that is employed in modern acoustic investigation.

It was in 1862 that Koenig began to be known to the scientific world as an investigator. An International Exhibition was held during that year in London, and the indefatigable instrument-maker was present, not merely for the purpose of displaying the

products of his labor, but to use these in the presence of physicists and to show practically the value of the graphic method of studying harmonic motion which had grown almost to perfection in his hands. The mathematical analysis of wave-motion had been abundantly brought out in technical treatises. Dr. Thomas Young, in the beginning of the present century, had pointed out the method by which a tuning-fork might be made to trace a record of its own vibrations, and his hint was put into practice nearly half a century afterward by Wertheim and Duhamel. But Koenig was the first to apply this method systematically to the registration of not only simple vibrations but also compound harmonic motion; and a large variety of such phonograms executed with apparatus of his device, and accompanied with the tracings of the corresponding theoretical curves, attracted much attention at the exhibition. The method has since been adopted in a number of other fields, notably in physiology for the analysis of animal motion, and in general physics for the measurement of minute intervals of time.

At the same exhibition in 1862 Koenig exhibited a wholly new method of making the effects of sonorous vibration easily visible by utilizing the delicate sensitiveness of flame to variations of atmospheric pressure. Four years earlier some noteworthy experiments had been made in America by Le Conte on the effect of such vibrations upon naked gas-flames; but no development had thus far been evolved from them. Koenig devised the manometric capsule through the medium of which the pressure at the outflowing jet is modified at will by sound-waves conducted to an elastic membrane. The motion of this produces pulsations in the gaseous fuel, and their effect on the flame is observed by looking at its image reflected from a revolving mirror. This beautiful method has been applied by its originator with much success to the study of the interference of sound, and to the investigation of the quality of musical sounds. No two vowels can be sung in succession to the delicate flame without impressing on it their separate individuality; and the eye is thus permitted to compare differences which the ear may recognize but not analyze. To see one's own voice in a mirror, to watch the successive phases of melody and harmony, to see two sounds interfering and producing visible silence—these are some of the revelations of the manometric flame.

This remarkable exhibition of Koenig's originality brought him prominently into notice everywhere. A detailed description of his work was published soon afterward by Prof. Tisko in Vienna, and from that day to this he has had no rival in the field which he had made his own. In every university where acoustics is taught Koenig's apparatus is the standard. Honors also were

soon accorded in acknowledgment of his merit. Among these may be mentioned a gold medal, in 1865, from the Société d'Encouragement at Paris; a gold medal, in 1867, from the International Exhibition at Paris; in 1868 the honorary degree of Doctor of Philosophy, from the university of his native city, Koenigsberg; and, in 1876, a medal from the Centennial Exhibition at Philadelphia. Before scientific assemblies he has been called upon to give the results of his investigations, including in them the Assembly of German Naturalists, in 1868, at Dresden; the American Association for the Advancement of Science in 1876 at Buffalo, and again in 1882 at Montreal; and the Electrical Exhibition at Paris in 1881, when he was specially visited by a large company of the most renowned of living physicists, including Helmholtz, Kirchhoff, Du Bois-Reymond, Clausius, Quincke, Mach, Kundt, Pahlzon, and Sir William Thomson.

The scientific papers of M. Koenig have been published almost entirely in the Annalen of Poggendorff and of Wiedemann. Most of these have been translated into French and published, in 1882, in a volume entitled Quelques Expériences d'Acoustique. To give an adequate idea of what is included in them would be impossible without going into detail. The volume includes a full account of Koenig's application of the graphic method and that of manometric flames. Both these methods are applied in an exhaustive investigation of the beat tones which result from the combination of two or more primary tones. Helmholtz discussed "differential tones" and "summation tones," whose existence was inferred from the results of mathematical analysis; and certain phenomena seemed for a time to confirm the conclusions of the great German physicist. But Koenig subsequently applied the most patient care and consummate skill in the experimental examination of these phenomena. Without detracting at all from the credit due Helmholtz for his splendid researches, it may now be safely said that Koenig's experiments have shown that differential and summation tones are due exclusively to the beats which the ear perceives when impressed simultaneously by systems of waves differing in length. The effect is physiological, and such combination tones are not at all re-enforced by resonators like the separate primaries that enter into combination. It is not necessary that beating tones shall be nearly in unison, as is stated in so many of the text-books.

The subject of musical quality was long an unsolved enigma for physicists. The principle underlying its explanation was foreshadowed early in the present century by the French mathematician Fourier, and soon afterward applied to acoustics by Ohm, whose name is now so familiar in connection with electricity. But to Helmholtz is due the full experimental proof that the

quality of every musical sound is determined by the number, orders, and relative intensities of the upper partial tones which accompany the fundamental whenever any ordinary instrument is sounded. Every such compound tone can be graphically represented by its own curve, the form of which may be varied not only by varying the elements just mentioned, but also by varying the phases in which the separate components are joined together. Helmholtz endeavored to test the influence of change of phase in using his apparatus for acoustic analysis, but the results were negative, and his conclusion was, that variation in phase has no physiological effect. Koenig has since attacked this problem, employing wave-sirens of his own invention, by which he has established quite conclusively the existence of this fourth element of musical quality. . . . The wave-siren may be briefly described as an apparatus in which a blast of air is forced through a narrow cleft against the edge of a moving plate or disk on which a series of determinate wave-forms have been cut. Each sinuosity, as it passes the cleft, interrupts the egress of air, so that a series of compound pulses are propagated whose grouping is determined by the form of the curved edge. The pitch is determined by the speed of rotation and the wave-length cut in the metal, through either the convex surface of a cylinder which rotates on its axis, or the edge of a disk which rotates about its center. A number of such wave-forms, each with its own wind-cleft, may be operated at the same time, with the same speed and with the same pressure of air at each cleft. They may be arranged to either coincide or differ in phase to any required extent. By the use of this new instrument Koenig has found that the complex sound obtained by the composition of a series of harmonics, of even as well as odd orders, quite independently of their relative intensity, has always its maximum of strength and its greatest acuteness of quality for a difference of phase of a fourth of a wave-length; the minimum of strength, and the softest quality, for a difference of phase of three fourths of a wave-length. It may be said that, if changes in the number and relative intensity of the harmonics produce differences of quality, such as are observed in instruments belonging to different families, or such as the human voice shows in the different vowels, the changes due to difference of phase between the same harmonics are yet capable of producing differences of quality at least as sensible as those which are noticeable in instruments of the same kind, or in the same vowels sung by different voices.

All musicians are able to perceive the general smoothness or roughness of a combination of sounds; but the analysis of the combination requires exquisite sensitiveness of ear for the detection of variation in both pitch and harmony. In the tuning of the standard forks which are issued from Koenig's laboratory, his

ear is usually found to be a sufficient guide, and at standard temperature these are rarely if ever found to deviate by more than a fraction of a single vibration from the value stamped upon them.

Within the last year Koenig has published two important papers: the one on beat tones due to the excitement of two separate motions of vibration on the same body; the other on tones due to the composition of waves of unlike form. These papers have an important bearing on the theory of musical quality. Their author is not yet sixty years old, and it is reasonable to expect from his many more contributions to the science of acoustics before old age interferes with the acuteness of his wonderfully accurate musical ear, or diminishes his power to do good work.

The following is a list of the principal contributions of M. Koenig to science, with their dates and the names of the periodicals in which they first appeared. The titles are translated into English, and the length of each article is approximately indicated by the number of pages covered:

1. On the Application of the Graphic Method to Acoustics. (Cosmos, 1862, pp. 27.)

2. Apparatus for the Measurement of the Velocity of Sounds at Small Distances. (Comptes Rendus de l'Académie des Sciences, October 13, 1862, pp. 2.)

3. Experiments relating to Wheatstone's Explanation of Chladni's Figures. (Comptes Rendus, March 27, 1864, pp. 7.)

4. A New Stethoscope. (Poggendorff's Annalen, 1864, pp. 2.)

5. Experiments to determine the Influence of the Movement of a Source of Sound on Pitch. (Koenig's Illustrated Catalogue, 1865, p. 1.)

6. On the Fixed Notes characteristic of Vowel Sounds. (Comptes Rendus, April 25, 1870, pp. 5.)

7. Manometric Flames. (Poggendorff's Annalen, 1872, pp. 36.)

8. A Tuning-Fork of Variable Pitch. (Poggendorff's Annalen, 1876, pp. 2.)

9. On the Phenomena produced by the Concurrence of Two Sounds. (Poggendorff's Annalen, 1876, pp. 62.)

10. On the Origin of Beats, and the Beating Sounds of Harmonic Intervals. (Wiedemann's Annalen, 1881, pp. 14.)

11. Description of an Apparatus for Lecture Demonstration of Beating Sounds. (Wiedemann's Annalen, 1881, pp. 4.)

12. Researches on the Difference of Phase existing between the Vibrations of Two Associated Telephones. (Journal de Physique, May, 1879, pp. 5.)

13. Researches on the Vibrations of a Normal Fork. (Wiedemann's Annalen, 1880, pp. 21.)

14. Harmonic Vibrations excited by the Vibrations of a Fundamental Sound. (Wiedemann's Annalen, 1880, pp. 13.)

15. A Method for observing the Air Vibrations in Organ-Pipes. (Wiedemann's Annalen, 1881, pp. 12.)

16. Remarks on Musical Quality. (Wiedemann's Annalen, 1881, pp. 26.)

17. On Beats and the Beat Tones of Two Vibratory Motions excited in the Same Body. (Wiedemann's Annalen, 1890, pp. 8.)

18. On Composite Tones, with Waves of Unlike Form. (Wiedemann's Annalen, 1890, pp. 9.)

CORRESPONDENCE.

THE PROHIBITION LAWS OF IOWA.

Editor Popular Science Monthly:

SIR: In the May (1890) number of the Monthly Dr. W. A. Hammond, in his article on Sumptuary Laws, makes statements with reference to the prohibitory liquor laws of Iowa which are not only misleading but incorrect.

It is not an offense under our law "for one person to ask another to take a drink." It is not contrary to law in Iowa to give intoxicating liquor to an adult person not intoxicated nor in the habit of becoming so, when such gift is made without any consideration being received or expected in return, and without subterfuge or attempt to evade the provisions of the code. The act of giving intoxicating liquors, except to minors or habitual drunkards, is not prohibited by statute, and the Supreme Court has decided that the simple act of giving is no offense (State vs. Hutchins, 74 Iowa Rep., p. 20); and so in the case supposed by the doctor there is neither a violation of the letter nor the spirit of the law.

It may be added, however, as pertinent to the point made by the doctor, that Iowans may legally obtain all the liquor they want by importation from other States; and that, notwithstanding the most stringent laws against its manufacture and sale within the State, it is not difficult to purchase any kind of liquor either by the drink or by the bottle; and that it is at least doubtful if the drink habit is decreasing.

JAMES H. TREWIN.

LANSING, IOWA, *May* 12, 1890.

EVIDENCES OF GLACIAL ACTION IN VIRGINIA.

Editor Popular Science Monthly:

SIR: The interesting article in your June number, by the Hon. David A. Wells, on evidences of glacial action in southeastern Connecticut, recalls to my recollection the fact of similar evidence in the State of Virginia. Slightly north of latitude 38°, in the extreme southeast corner of Orange County (my native county), on a farm—originally, and I presume still, known by the name of *Wood Lawn*, or the Minor Farm—are two large bowlders, similar to those described by Mr. Wells. One of these bowlders is split in half; one half retains an erect position, while the other lies prostrate, forming a large, flat table. I speak of them as they appeared many years ago, although I presume their appearance is the same to-day. There are other bowlders of a like character in that vicinity, and, if they were visited and described by one competent to do so, a very interesting article might be written, and perhaps prove a valuable addition to the science of glacial action.

FRANCIS MINOR.

ST. LOUIS, *June*, 1890.

EDITOR'S TABLE.

MR. SPENCER'S PLACE IN PHILOSOPHY.

AS we had occasion not long ago to remark, the philosophy of evolution is a great stumbling-block and rock of offense to transcendentalists—that is to say, to people who want a philosophy founded on emotion and soaring beyond all experience into the region of the absolute. If such people do not like the evolution philosophy, it is natural that they should dislike the evolution philosopher *par excellence*, Mr. Spencer. His name seems to send a chill through those whose ambition it is to discover truth by some royal road of *a priori* assumption; and now and again these persons take courage to express all the repugnance they feel to what they regard as his desolating doctrines. Occasionally, also, though not very often, an attempt is made to show that Mr. Spencer is not so much of a philosopher after all—only a kind of all-round writer on a great variety of subjects, in not one of which he has any superior competence. Many of our readers will remember that some weeks ago a certain person wrote to the New York Times to express his own low estimate of the value of Mr. Herbert Spencer's philosophical work, and his grave doubts as to the rank assigned to him in the world of thought by really competent judges. This gentle-

sent, who evidently signed "Outsider," had not been able to find that mathematical specialists thought very highly of Mr. Spencer as a mathematician, or that specialists in biology ranked him high as a biologist, or that men eminent for their historical knowledge regarded him as an authority in their special department, and so on and so on. Evidently this writer had somewhat singular notions as to what was required to make a philosopher. Not only is it impossible that Mr. Spencer should be a specialist in all the branches of knowledge upon which his system has a bearing, but it is quite unnecessary that he should be such in even one branch. His specialty consists in his power of co-ordinating the general results of different lines of inquiry; and his claim to rank as a philosopher depends on the success with which he has accomplished this task. All that can properly be demanded of Mr. Spencer, or any philosopher, is that he shall not misunderstand or misstate the results of the special sciences with which he may have to deal. If "Outsider" had been in a position to declare that mathematicians had examined Mr. Spencer's work, and found it very faulty on the mathematical side; that biologists, in like manner, had found it weak on the biological side; and that in general his system was, to a serious extent, based upon erroneous conceptions of special facts and laws, he would have made a very damaging criticism. He did not pretend, however, to be in a position to do anything of the kind; but simply attacked Mr. Spencer for not being, what no one man could possibly be, a specialist in half a dozen sciences at once.

The principal result of "Outsider's" attack was that a number of persons came forward, many over their own signatures, to vindicate Mr. Spencer; and so effectually was the work done, and such a revelation did the whole controversy afford of the hold Mr. Spencer had upon the thinking men of this country, that a very suspicious person might have conjectured that "Outsider's" secret object had been to get as much good said of Spencer as possible, and bring him and his works into greater prominence than ever. The personal interest which we have for years felt in the great English philosopher—an interest which the sketch of the late Prof. Youmans, published a couple of months ago in this magazine, will in some measure explain—led us to attempt in the columns of the Times a concise yet comprehensive statement of the testimonies that had been borne to the value of his scientific and philosophical work by the very highest authorities. "Outsider" had asked what the specialists thought of Mr. Spencer; we had no difficulty in showing what the men who commanded the widest view of the fields of philosophy and science, and who in that sense were the specialists by whom his work should be tried, thought of him. In philosophy, the names cited were such as Lewes, McCosh, J. S. Mill, Morell, and Ribot; in biology, such as Mivart, Ray Lankester, Huxley, Darwin; and in general science and history, Masson, Proctor, Tyndall, Grant Allen, Leslie Stephen, and Tylor. All of these, at one time or another, have in the amplest manner borne testimony to Spencer's philosophic genius, to the acuteness of his thought, the depth of his insight, the fertility of his methods, the sagacity of his judgment, the keenness and truth of his scientific perceptions—one remarking upon this quality or group of qualities, and another upon that. As further evidence of the impression Mr. Spencer has made upon his age, we gave the leading facts relating to the reproduction of his works in foreign countries and their translation into foreign tongues. In Russia, in Italy, in France, in Germany, Spencer's works may be read in the national tongue, and have powerfully molded philosophical opinion. The facts thus brought forward were not far to seek;

any one even moderately acquainted with the course of modern thought can hardly fail to know that these things are so; and it is difficult to understand how a writer vouched for by the Times as a person of very superior acquirements could have managed to remain ignorant of them. Possibly he is one of those "specialists" whose information is so very special that virtually they may be said to go about with blinkers over their eyes that shut out all side views. But in that case the man who wears the blinkers should not constitute himself a judge of what he does not and can not see.

Another objection which our critic raised was that the laws of evolution embodied in Mr. Spencer's system had never served as the basis for prediction, and so far lacked full confirmation. This criticism was singularly pointless. Prediction, in the sense understood in the sciences say of astronomy and chemistry, is not to be expected in connection with a general system of philosophy—the aim of which is to correlate diverse phenomena under a few very general laws. In another sense Mr. Spencer's system does lend itself to prediction, inasmuch as it has traced for us the laws of development of the individual mind and of society, and so far enabled us to anticipate what would fall under our observation in newly discovered societies—could there be such—given one or two leading facts as to their environment and the stage of civilization they had reached. We credit the science of geology with a power of prediction when the geologist in an Old Red-sandstone country is able to say positively that there is no use in prospecting there for coal. Why not allow the evolutionist equal credit if he is able to say beforehand of a given community that the mathematical faculty will be found to be very feebly developed in it, but that the poetic may be found to have made some advance; or if, taking two widely separated stages of a nation's history, he is able in a general way to fill in the intervening course of events, very much as Mendeleef describes a certain set of elements yet to be discovered?

When Mr. Spencer says, "With the repression of militant activities and decay of militant organizations will come amelioration of political institutions as of all other institutions," he makes a prediction founded on the general principles of his system—a prediction in which many who take their ideas from poetry and romance might not be disposed to concur. It remains to be seen whether the evolutionist is right, or whether those are right who hold that without war the higher civic and personal virtues would decline and wither. The difference between the two opinions is that the one is founded on a long course of study, and is correlated with a multitude of established facts; while the other is rather a matter of sentiment than of reasoned conviction.

We do not intend, however, to pursue further a controversy which was carried on to considerable length in the columns of the Times, and which developed so much of sympathy with, and so little of decided opposition to, Spencer as to cause the editor of that paper to exclaim, "Where are the foes of Spencer?" and to express his surprise at the backwardness of certain persons, who are supposed to regard the doctrine of evolution as false and dangerous in the extreme, in availing themselves of the opportunity of stating and defending their convictions. It remains but to say that the value of the synthetic philosophy is not bound up with the accuracy of every scientific or historical statement its author may have made, nor yet with the absolute solidity of his metaphysics. It is a great colligation of the laws of life and development. It teaches us to understand the world and human society, and gives to every one who studies it a superior power of discernment in many fields of observation. The evolutionist can predict in this sense

at least that, in a broad way, he knows what to expect, and does not look for grapes from thorns or figs from thistles. He sees cause and effect, action and reaction everywhere, not like some specialists in certain selected spheres exclusively. He believes in orderly progress, knowing that great processes of development can not be very materially hastened.

In the field of education the views derived from the general theory of evolution have been found of the very greatest value; and were education to-day free from the trammels of politics, and were it commanding—as, but for its connection with the state, it would command—the best thoughts and the best energies of a host of freely competing educators, the improvement in educational methods directly due to the new views would be most conspicuous.

The evolutionary philosophy is a practical one, and it is to-day on trial; its principles are more or less penetrating and permeating the community; and the more they do so, the more they are confirmed by experience, and become impressed on the mental habits of individuals. Of what competing philosophy can the same be said? It is to this growing experience of the race, therefore, that appeal must be made if the validity of the general theory is to be questioned.

LITERARY NOTICES.

THE EVOLUTION OF MAN AND CHRISTIANITY. By the Rev. HOWARD MACQUEARY. New York: D. Appleton & Co. Pp. 410.

THE assertion of Prof. Le Conte, which furnished the motive, as the author avers, for this book, that we are on the eve of the greatest change in traditional views that has taken place since the birth of Christianity—a change involving a reconstruction of Christian theology—is verified by events which have taken place during the current year in the official centers of the most orthodox Protestant bodies. The debate in the Congregational churches about future probation; the creed revision which has been resolved upon by the Northern Presbyterian Church; the provision by the English Presbyterian Church of a place for those who believe in the evolution and extreme antiquity of man; and the retention of Professors Bode and Briggs by the Free Church of Scotland after their persistent avowals of doctrines far more novel to the Calvinistic theology than those for which Prof. Robertson Smith was lopped seven years ago, are signs the meaning of which can not be mistaken. The right to criticise the Bible as any other book is criticised; to investigate phenomena regarded by the Church as supernatural in the same way that ordinary phenomena are examined; and to probe the foundations of Christian faith to the bottom, has asserted itself there and has commanded a hearing. Modern theology can hardly be blamed for the existence of errors which were ingrafted upon it during the ages of darkness and ignorance; but it ought to have been more prompt to recognize these errors and correct them, rather than by cherishing them till their absurdity was universally seen to have given temporary advantages to the enemies of Christianity. Professing, as it does, to seek the truth as science is doing, it should welcome every effort to make the truth more clear; and even mistaken searchings for truth are better than persistent adherence to what has been proved false. Science, the friend and devotee of truth, can never do more than establish and make more accessible to men the truth in religion; and it is behaving as the truest ally of religion when it throws the light of a better and more exact knowledge upon dogmas that were conceived by men when their sources of information were scanty and imperfect or did not exist.

The author of The Evolution of Man and Christianity is a clergyman of apparently good standing in the Protestant Episcopal Church. He goes further in the criticism and analysis of doctrine than any other author who has written from within the Church. He believes that a recasting of theological thought is necessary to meet the advance that has been made in physical science, which is destined profoundly to modify our idea of miracles; biblical criticism, which has cast new views on the origin and character of the sacred books; and the social

movement, which, assuming an anti-Church attitude, is leading the people into unbelief; and he here lays down the lines along which he thinks the revision should be made. The points of evolution and the antiquity of man have already been conceded by the best thinkers in the Church, but Mr. MacQueary has outrun them by applying evolution to the soul as well as to the body of man. The doctrine of the fall of man is rejected as irrational and contrary to the theory of evolution, yet our progenitor sinned, or freely violated moral, divine law, and transmitted to us an inheritance of corrupt habits; but Jesus, by what he taught, did, and suffered, has more than repaired the evil which resulted from Adam's transgression. The books of the Bible are believed to be works of slow growth, or collations made from documents or notes left by earlier writers; but "even the most radical skeptics admit that the books of the New Testament furnish us the essential facts of our Lord's life and teachings." The question as to the miracles is made one of evidence; the scientific man does not deny the possibility of anything. The author believes in prayer and Providence and in miracles, or that God has actually wrought extraordinary events. Some of the recorded miracles are treated as cases of faith-healing, some as invested with a poetical significance, and some as exaggerated versions of older traditions. The resurrection is believed to be spiritual and not of the earthly body, and the resurrection of Jesus and his forty days' sojourn with his disciples is interpreted as an investment with a spiritual body like that described in St. Paul's chapter on the resurrection. The miraculous birth of Jesus from a virgin, though its possibility is not denied, is regarded as "a poetic description of a great fact." The theory of verbal inspiration is treated as of heathen origin and as contradicted by the Bible itself; but insomuch as God has sent religious as well as philosophic and poetic geniuses into the world, who, though not absolutely infallible, are infallible so far as they discover and reveal truth, we have inspiration. The doctrine of the Trinity is traced back to extremely ancient times, and may be looked upon as a symbolic description of the manifold Infinite Spirit of God. The divinity of Christ is resolved into "the closest and most vital union of the Spirit of Jesus with the Divine Spirit from whom it sprung," so that "he was the divine under the limits of humanity." Instead of the Calvinistic doctrine of the atonement, which is exploded by evolution, showing its inconsistency with any true idea of God, we are shown Jesus saving his people from their sins, "first by setting them an example of perfect obedience to God's will, and then by assigning a motive to virtue strong enough to enable men to live soberly, righteously, and godly. That motive is the fatherly love of God toward man, which love was manifested in the mission and person of Jesus." Heaven and hell are believed to be spiritual conditions, not places; future punishment, though real, to be limited by the possibility of the ultimate recovery of the soul by infinite power, wisdom, and love. Immortality is accepted. The author's purpose has been, not to stir up bitter controversy, but to help those who are troubled by the difficulties of traditional and popular theology to a plane of thought where all will be made more clear to them; and he anticipates as the result of previous discussions an elevation and purification, a dematerialization and spiritualizing of our views on all the subjects involved.

While no one may be ready to accept all the author's conclusions as he states them, the book must be hailed as an earnest and honest attempt to reflect the light of science and modern research on the most difficult points of Christian doctrine, and to make the way more easy for their acceptance in their true sense. Whatever may be the fate of his particular views, his essay will tend to stimulate thought, and that in the direction of freeing religion from the excrescences which traditional superstition has fastened upon it.

THE PHYSICAL PROPERTIES OF GASES. By ARTHUR L. KIMBALL. Boston: Houghton, Mifflin & Co. Pp. 238. Price, $1.25.

REGARDING imitation as the most sincere praise, the International Scientific Series has received two very hearty indorsements lately, by the announcement of two series of scientific books, which follow its plan in part. One of these originates in England, and is also published in this country; the other is the Riverside Science Series, of which the

second volume is now before us. The publishers describe the latter series as a collection of books setting forth the achievements of scientific and mechanical skill at the present day. The volumes are intended to be as free as possible from technical terms, and to deal but little with matters of theory. Prof. Mendenhall's Century of Electricity, already issued, has been made the first volume of the series. Mr. Kimball's book is devoted to that department of physics usually known as pneumatics. It gives the properties of gases, and the current theories in regard to their constitution and behavior, in language that is readily understood and free from mathematics. A chapter is devoted to Geissler tubes and the phenomena of the radiant condition of matter as developed by Prof. Crookes. The text is illustrated with about forty cuts of apparatus.

THE UNKNOWN GOD; OR, INSPIRATION AMONG PRE-CHRISTIAN RACES. By C. LORING BRACE. New York: A. C. Armstrong & Son. Pp. 336. Price, $2.50.

THE author accepts the "modern method" of studying ethnic or heathen religions, by looking for what is good in them rather than searching for their defects or trying to show their inferiority to the highest—or his own—religion. He inquires how the man of other races and times regarded the problems of the universe; what was his conception of the primeval cause, how he considered his relation to it, and how far that relation affected his daily life and practical morals. In pursuing this study he expects to find with man in all ages and races some evidences of the inspiration of the Divine Spirit. Dealing first with the Hamitic and Semitic races, a period is found in Egypt in which a belief in the one God existed in the minds of the scholars and priests. Then, among the Semitic tribes of the valley of the Euphrates, the penitential psalms and prayers of the Accadians are stamped with a monotheistic spirit. Among the Aryan races the belief in God and a future judgment is discovered in the mysteries of the Greeks, and the faith in a spiritual God or Zeus is discerned in their early poetry, before the idea had been degraded by the myth-making fancy. "The evidence from the Greek dramatists and many of the ancient writers is here overwhelming that one spiritual God was at certain periods adored by considerable numbers of the Greek race." Similar evidences are found in the religion of Plato and Socrates, and of the Stoics. Monotheism and moral purity are found to be marked characteristics of the Persian religion of Zoroastrianism. The old Vedic hymns furnish the proof of Hindoo monotheism in the worship of Varuna, the heaven-god. The fullest descriptions are devoted to the Buddhist faith, which the author regards as "in a high degree inspired, and as an instrument in the hands of Providence for the elevation and purification of Asia." The final chapter is on the biblical argument for the inspiration of the heathen. The work is not designed for an attack on the heathen religions, or as a defense of Christianity; but rather to show what great truths have inspired the pious heathen of the past.

MIDNIGHT TALKS AT THE CLUB. Reported by AMOS K. FISKE. New York: Fords, Howard & Hulbert. Pp. 298. Price, $1.

THE "talks" which this little volume contains embody earnest and more or less conflicting opinions on some of the more serious subjects which are being discussed at the present time. It is not the purpose of the book to put forth judgments of startling novelty, and many readers will find in the utterances of one or another of the speakers represented simply their own views, though they may never have expressed them in the same way, or, in fact, at all, or perhaps were never quite conscious before that they held these views. The first subject discussed is temperance; from that the talk goes to the lack of practical work by the churches, and is led through the question of Sunday observance up to a discussion of religion in general. Political immorality is the subject of the next conversation, and the somewhat allied topic of the Irish Americans comes up for attention later. Most of the talks which follow concern religious matters, such as superstition and worship, the Scripture fetich, the teachings of Moses and the prophets, and the usefulness of religious delusion. Other fields are entered in discussions of the value of human evidence and the power of personality. Throughout the volume the modern progressive views are

the ones most fully presented, and the tone of the book is against submission to prejudices, and favors the recognition of whatever good there is in every institution, opinion, or person.

STUDIES IN HEGEL'S PHILOSOPHY OF RELIGION. With a Chapter on Christian Unity in America. By J. MACBRIDE STERRETT, D. D. New York: D. Appleton & Co. Pp. 348. Price, $2.

HEGEL, the author says, is recognized as a thinker whose comprehension of thought and its method no student of philosophy can fail to acknowledge as great among the greatest. He was radically and throughout a theologian. All his thought began, continued, and ended in that of divinity. He tried in his Philosophy of Religion to satisfy man's demand to know what there is in religion; to discover and state its speculative idea. "But with him the speculative was both vital and practical—the very life of the spirit throbbing through all the tangled mass of varied religious phenomena in the world's history." His whole logic is interpreted as being but "his explication of the nature and activities of God immanent in the actuality and order of the world, and transcendent as its efficient and final cause." Agnosticism, both atheistic and Christian, is repudiated throughout. "God knowable because self-manifesting, and man in duty bound to study this knowledge, are with Hegel self-evident and demonstrable principles." While he is regarded as a pantheist, in the Christian sense, his doctrine of God is the Christian and not the deistic or pantheistic doctrine. "In him all finite beings find, not lose, their reality." Hegel's philosophy at his death had pervaded universities, state, and church, and for ten years afterward remained the foremost intellectual phenomenon of the time. But the interpreters of his system, each seeking in it his own dogma, and finding it, have succeeded in dismembering it into parts whose various aspects have seemed to various types of mind to be the whole system. While in Germany it has almost ceased to exist as a professed system, its spirit and method have become inextricably entangled with the whole thought and culture of the country, and are the leaven at work in its current philosophy. In Great Britain it has also greatly influenced philosophic thought, though accepted and expounded as a system by none. In England and America the interest in Hegel is chiefly owing to the relation of his thought to religion and to Christianity. His thought attracts Christian thinkers seeking for intellectual comprehension of religious experience, faith, and facts. They are drawn to him "because they find him thinking weightily on the same" subjects; and yet the chief opposition to the study of Hegel "comes from the *odium theologicum* of Christian teachers." But the students of the Hegelian philosophy disclaim being what the term Hegelian, either in the popular or scientific sense, would imply, for they are mastering and using his method, rather than accepting all the results which that method yielded to him. In Dr. W. T. Harris's opinion, no other work better deserves translation into English than the Philosophy of Religion. But any real translation of it would be inadequate, and would need a further translation into expository paraphrase. Dr. Sterrett, therefore, instead of a translation, offers "studies" of his system. The purpose of the volume throughout is apologetic. "It is written with faith and in the interest of 'the faith,' though demanding an almost antipodal orientation or point of view to that of both deistic orthodoxy and ecclesiasticism." Pertinently to the latter feature of his course, the author well says that "it is mere time-serving to manufacture evidences when there are none. It is as useless as it is wrong to attempt the 'hard-church' method of overriding reason and conscience with the mere weight of an uncriticised authority. It is both anti-theistic and anti-Christian to profane the secular in the interest of the sacred."

ORGANIC EVOLUTION AS THE RESULT OF THE INHERITANCE OF ACQUIRED CHARACTERS ACCORDING TO THE LAWS OF ORGANIC GROWTH. By Dr. G. H. THEODOR EIMER. Translated by J. T. CUNNINGHAM. London and New York: Macmillan & Co. Pp. 425. Price, $3.25.

THE translator of this work explains, as his reason for presenting it to the English-reading public, that he had become dissatisfied with the "uncritical acceptance" accorded to Prof. Weismann's theories of heredity and variation by many English evolutionists. He was inclined to attach more

importance to the causes of variation than to any of the other problems considered by Darwin, among which functional activity and external conditions seemed the most powerful. He was thus led to believe that a deeper insight into the phenomena of evolution would ultimately be obtained by pursuing the line of inquiry suggested by Lamarck, than by continually searching for new instances of adaptation to be explained by the Darwinian formula. While in this frame of mind he was "delighted to find" that Weismann had to contend with a formidable opponent in his own country, and concluded that he could not for the present oppose the progress of his views more effectively in England than by publishing a translation of Prof. Eimer's arguments. It had seemed to this author long ago to be of the greatest importance to undertake an investigation of the question whether the modification or variation of the species of animals is not governed by definite laws. The Darwinian theory suggested none. The investigation of the laws of variation included the question of the causes of variation. There was likewise a gap in the Darwinian theory where these should be explained. The principle of utility, the selection of the useful in the struggle for existence, did not explain the first origin of new characters, but only, and that partially, the progress and the gradually effected pre-eminence of those characters. If we could know, the author assumed, all the natural laws which have operated in the evolution, and which operate in the existence of a single animal or a single plant, we should understand the laws of the organic world altogether. Applying this principle, the unreserved study of a single species of animal, the author declares, led him to the discovery of a whole series of laws, which the extension of the investigation to other species showed to hold good generally. This animal was the wall-lizard (*Lacerta muralis cærulea*), a species of remarkable variability, with which he became acquainted on the rocks of Capri. The result of his researches, which were extended to various classes of animals, "was the recognition of the dominion of laws in the process of variation, not only of the lizard, but also in the most diverse tribes of the animal kingdom; these laws holding firstly in the variations of marking, previously regarded as quite indifferent, unimportant, or fortuitous, but also applying to other characters. I was able to demonstrate that variation everywhere takes place in quite definite directions which are few in number, and I was able on the basis of my observations to put forward the view that the causes which lead to the formation of new characters in organisms, and in the last result to their evolution, consist essentially in the chemico-physiological interaction between the material composition of the body and external influences. Finally, I succeeded, through the facts I established, in referring the separation into species, . . . in connection with the rest of my views, to natural causes." Previously to presenting these results in the present volume, a brief review is given of the newest theories concerning evolution. The translator has endeavored to make his work sufficiently English to be readable, and to preserve the full force and exact significance of Prof. Eimer's expression.

A Short Course of Experiments in Physical Measurement. By Harold Whiting. In Four Parts. Part I: Density, Heat, Light, and Sound. Cambridge: John Wilson & Son. Pp. 278.

The course of laboratory work which this book is to comprise covers the ground of both the "minimum" and the "maximum" requirements in physics for admission to Harvard College, and it is intended also to serve as a preparation for courses in mechanical and electrical engineering in other institutions. Mental training is the chief object aimed at, through the care required, and the practice in inductive and controlled methods secured. The policy of the book is rather "to show how comparatively accurate results may be obtained by rough apparatus, than to explain the use of instruments of precision, which in the hands of a student are apt to give erroneous results." The author states that not so much mathematics is involved in these experiments as would appear from a first glance, because many proofs are given in full here which in most textbooks have been taken for granted. The volume is illustrated with many cuts of apparatus. The second, third, and fourth parts are to contain experiments in other departments of physics.

LABORATORY MANUAL OF EXPERIMENTAL PHYSICS. By ALBERT L. AREY, C. E. Syracuse: C. W. Bardeen. Pp. 200. Price, 75 cents.

NEGLECT of experimental science-teaching will not be much longer excusable for lack of suitable laboratory manuals. Mr. Arey's book consists of brief directions for seventy experiments in the several departments of physics, with suggestive questions as to what is shown by each experiment. The right-hand pages are left blank, or contain forms for entering the results of observations. The experiments are adapted to pupils in secondary schools, and are characterized by involving measurements, the author being convinced that "vastly greater mental discipline will be derived by the student from quantitative experiment" than from qualitative. It has been a part of the author's plan, also, to devise inexpensive apparatus with which results may be obtained sufficiently accurate to point conclusively to the law under consideration. Directions for making many pieces of this apparatus are appended to the book. The text is illustrated with fifty-six figures.

THE CHEMISTRY OF PAINTS AND PAINTING. By A. H. CHURCH, F. R. S. London: Seeley & Co., Limited. Pp. 310. Price, $1.75.

ARTISTS are supplied in this volume with a great deal of practical knowledge concerning the chief chemical and physical characters of the materials and processes that they use. There are other books that treat of the pigments employed, but this deals also with painting-grounds (paper, plaster, stone, wood, and canvas), with vehicles and varnishes, and with methods and results. In describing the materials which artists use, the sources from which they are obtained are told, and in many cases the mode of preparing them is given. Tests for purity and genuineness, that take but little time or apparatus, have also been inserted. Chapters that will contribute to the durability of the artist's work are those on the permanency of pigments, and the conservation of pictures and drawings. Exact knowledge in regard to permanency is furnished in the chapter containing results of trials by Mr. F. W. Andrew, Prof. Rood, Prof. Hartley, and by Dr. Russell and Captain Abney, as reported to the South Kensington Museum. The volume is adequately indexed, and its mechanical work is excellent.

THE TRUE GRASSES. By EDUARD HACKEL. Translated from Die natürlichen Pflanzenfamilien, by F. L. SCRIBNER and EFFIE A. SOUTHWORTH. New York: Henry Holt & Co. Pp. 228.

PROF. HACKEL'S monograph on the grasses, here translated, was contributed to the great German work on the Natural Families of Plants, edited by Drs. Engler and Prantl. The book consists of a botanical key to the *Gramineæ*, through which are interspersed full descriptions and cuts of the economically important species. The grass family includes a large number of plants which are of great value as furnishing food for man and for his domestic animals, as well as supplying a great variety of products used in the arts and in medicine. Among these are Indian corn, sugar-cane, bamboo, the grains, and the fodder grasses. The opening chapter gives an account of the general structure, morphology, and physiology of the *Gramineæ*. The translators have added an introduction, giving an example of how a botanical key is used, a full glossary, and an index, in order to make the volume more useful as a text-book in agricultural colleges. The illustrations number over a hundred.

EVOLUTION, ANTIQUITY OF MAN, BACTERIA, etc. By WILLIAM DURHAM, F. R. S. E. Edinburgh: Adam & Charles Black. Pp. 127. Price, 50 cents.

THE Messrs. Black issue this little volume as the first of a series under the general title Science in Plain Language, the design of which is to impart the general results of scientific investigation in common language, and without a great deal of detail. The book consists of about twenty short articles grouped under four heads. Those in the first group deal with evolution and primeval man, those in the second are devoted to the lowest living organisms, the third contains papers on color in plants and animals, and in the fourth various movements in plants are described. Each essay is complete in itself, yet their subjects are so selected that they are all connected, and all unite to form a general picture of the evolution and general phenomena of life.

A Bibliography of the more Important Contributions to American Economic Entomology has been prepared by *Samuel Henshaw* for the Department of Agriculture. Parts I, II, and III, already issued in one volume, contain the more important writings of Benjamin D. Walsh and Charles V. Riley. Those by B. D. Walsh number 385 titles, those by Walsh and Riley jointly are 478, while the writings of Prof. Riley alone number 1,555. A general index to the list and indexes of new names proposed are appended to the volume.

The seventh edition of *Blozam's Chemistry* (Blakiston, $4.50) follows the sixth after an interval of only two years. It has been revised and edited by Prof. *John M. Thomson* and *Arthur G. Blozam*, who give the following statement in the preface as to the changes they have made: "In the Organic division of the book an attempt has been made to give concise accounts of more modern research—such as Raoult's method for the determination of molecular formulæ, and Fischer and Tafel's investigations on the synthesis of sugars. In the same division the Chemistry of Vegetation has been in a great measure rewritten to suit more modern views. Those portions of the book relating to Explosives, to which the work to some extent owes its reputation, have been revised, and are treated of as fully as possible within the limits of a general text-book." The volume has been increased in length about ten pages.

A second edition of *The Microtomist's Vade-mecum*, by *Arthur B. Lee*, has been issued (Blakiston). It is much larger than the original English edition, and in fact is not based upon that, but upon the French work with a different title, by Lee and Henneguy, published two years later. Besides including the important advances made in its field since 1885, the present Vade-mecum differs from the first in being much less historical and much more critical. The subjects of most importance in a technical manual have been treated more fully, and those which are less important, or whose best place is elsewhere, have been thrown into the background. Among the chapters that have been extended are those on fixing, impregnation methods, paraffin and celloidin imbedding, and the special methods of embryology, of cytology, and of neurology. The volume has an index, and its paper and print are excellent.

A Clinical Study of the Skull—the tenth of the Toner Lectures—by Dr. *Harrison Allen*, is a contribution to the morphological study of diseased action. The materials on which it is based were found in the Collections of the Academy of Natural Sciences of Philadelphia and of the College of Physicians, Philadelphia, which together contain more than nineteen hundred specimens of skulls. Washington: Smithsonian Institution.

The March Bulletin of the Connecticut Agricultural Experiment Station is a paper on *Fungicides*, or applications for such diseases as the black rot and the mildew of the grape, by *Roland Thaxter*. The applications recommended are Bordeaux mixture—sulphate of copper and quicklime, with water—and ammoniacal carbonate of copper; which are sprayed over the plants. The treatment is most effectual when it is applied preventively.

The second year's work of the Agricultural Experiment Station of the University of Illinois, ending July 1, 1889, comprised analyses of fodders and of various food products, with numerous items of new work taken up from time to time. Four bulletins were issued, reporting experiments upon oats, upon corn, experiments with ensilage, and experiments of the effects upon the hay of cutting certain grasses and clovers at different periods of growth. Bulletin No. 7, November, 1889, is upon the Biology of Ensilage; and Bulletin No. 8, February, 1890, records a series of field experiments with corn.

The work of the Massachusetts State Agricultural Experiment Station, as presented in its report of 1889, was carried on in the same principal lines of investigation as in preceding years. A very important part of it is represented in the investigations of fungoid diseases by Prof. Humphry. To the experiments for determining the cost of feed for the production of beef and pork were added similar ones respecting beef and mutton. Laboratory work was especially large, and extended in various directions.

References to the Constitution of the United States, which has been prepared by

William E. Foster for the Society for Political Education, might be described as a bibliography. The references are historical—to the antecedent influences, the framing and adoption of the Constitution, and Constitutional History since 1789—and cite numerous papers and books on each branch of the subject. In the Appendix are given the constitutional interpretations since the civil war affecting the question of national or State supremacy.

Letters from Waldegrave Cottage, by the Rev. *George W. Nichols*, is a collection of reminiscences, portrayals of eminent or lovable men, and rural sketches, which, published first in a monthly magazine, are gathered up into a single volume. The author claims descent from the Earl of Waldegrave, and is able to point to the graves of ancestors among the venerable tombs of Trinity and St. Paul's churches, New York. The essays include sketches of life, scenes, and persons at various places in Connecticut and Massachusetts, Yale College, Brooklyn, N. Y., etc., notices of famous divines and men eminent in the life of society and the State, and other items of personal reminiscence such as usually furnish pleasant reading even to strangers; and there is an air of repose about the whole that is refreshing to the reader vexed with the controversies of the day. (Exchange Printing Company, New York.)

The historical novels published by W. S. Gottsberger form an attractive-looking department in the library, and the promise offered by their neat exteriors is usually more than fulfilled when they are read. They include pictures of Oriental antiquity, the classical period, the middle ages, and heroic or romantic episodes of later times, sketched by the master artists in their respective fields. Among the latest of these publications is *Nero*, by the German *Ernst Eckstein*, one of the most famous and most prolific of the writers of this class. Its special effort is to describe how Nero, from the gentle and noble character he is said to have been by nature, became transformed into the inhuman monster of whom such incredible tales are told. This purpose leads to the more comprehensive treatment of the separate stages of development rather than the excesses of the matured criminal.—In *Joshua*, Dr. *Georg Ebers* has attempted to treat the wanderings of the Israelites during and after the Exodus in the form of a romance. In it he has made use of his own observations in the field covered by the wanderings, and of the latest results of archæological explorations in the Nile Delta; and in the "scenery of the drama" he has copied as faithfully as possible from the landscapes he beheld in Goshen and on the Sinai Peninsula. For the incidents he has relied on the Bible and Egyptian records.—*Ekkehard*, a Tale of the Tenth Century, has been written by Herr *Joseph Victor von Scheffel*, in the belief that a union of history and poetry, for working purposes, would be detrimental to neither. The materials from which it is composed are derived from the tales of the monastery of St. Gall, begun by the monk Ratpert, and continued to the end of the tenth century by Ekkehard the Younger, contained in the folios of the Monumenta Germanica, which are described as being, in spite of much *naïveté* and awkwardness, "charming stories, made up of traditions of older comrades, and accounts of eye and ear witnesses." Quite unconsciously, the author adds, "these annals carry us far beyond the boundaries of the cloister walls, presenting the life and aims, the culture and customs of the Alemannia of that period with all the fidelity of a picture painted from nature."

The Truth-seeker Company publishes a symposium on the question of the *Existence of a Positive, Constructive Side to Free Thought*, to which some twenty of the most prominent representatives of the school described as freethinkers are contributors. Besides the direct question, the character and scope of the constructive side are considered by those who answer affirmatively, or the reason why there is no such side if the answer is negative.

In his paper on *Etruscan and Libyan Names; a Comparative Study*, Dr. *D. G. Brinton* seeks evidence of affinity between the race of which the Berber tribes of the present are the representatives and the ancient Etruscans. In a former paper (October, 1889) he supported his theory by comparison of physical traits, customs, arts, and language; in the present one he carries out, to a limited extent, a comparison between

the proper names preserved in the oldest Libyan monuments and a series of similar names believed to be genuine Etruscan.

In its third edition, the *Directory of Writers for the Literary Press*, compiled by *W. M. Griswold* (the author, Bangor, Me., $1), has been expanded to fifty-nine pages. It gives the full names of writers, their addresses, professional positions, date of birth, and subjects on which they write. The addresses of the chief American and English periodicals, literary clubs, and colleges are also included in the directory. A list of authors recently dead is appended.

A number of special papers by Dr. *Edgar A. Mearns* on the natural history of the Western Territories and other localities testify to his industry and carefulness in that study. *Description of Supposed New Species and Subspecies from Arizona* gives ten species and some subspecies of rodents (a squirrel, a musk-rat, mice, hares, etc.), with detailed measurements and characteristics. A paper on *Arizona Mountain Birds* furnishes illustrations of a feature which the author desires to emphasize, of the extension of the Alpine flora and fauna of the Rocky Mountains southward into this Territory, where they appear on the mountains, with characters changing according to the altitude, "like islands in a region of more southern aspect." Other papers include a list of the *Birds of Fort Klamath, Oregon*, collected by Lieutenant Willis Wittich, annotated and added to; and an *Addendum* to a list of the *Birds of the Hudson Highlands*, with annotations. A welcome feature of these papers is that good English names are given for all the species. Two other papers, relative to Dr. Mearns's work, are published by the Herbarium of Columbia College. They are a list of the plants collected by him at Fort Verde and in Mogollon and San Francisco Mountains, by N. L. Britten; and the General Floral Characters of those regions, by H. H. Rusby.

In a *Tube-building Spider*, Mr. *W. L. Poteat*, of Wake Forest College, N. C., publishes some interesting notes on the architectural and feeding habits of *Atypus niger*. In asserting that "quite unaccountably American naturalists have taken comparatively little interest in spiders," the author seems to overlook the voluminous contributions of McCook, which have been acknowledged to be among the most valuable that have been made; the more modest but very intelligent and original researches of the Peckhams; and the work of other authors whose papers have come to us from time to time—all showing that the subject has not been neglected.

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POPULAR MISCELLANY.

Instruction by Experimental Methods.—As represented by Prof. J. F. Woodhull to the American Institute of Instruction, the New York College for the Training of Teachers has model classes of pupils in all grades to which apprentice teachers are assigned at stated hours to give experimental instruction in science. In the primary and grammar grades the experiments are performed by the teachers in presence of the pupils, after which the pupils are questioned concerning what they have observed. They are also allowed to examine the objects closely in hand. Familiar, every-day objects, which are convenient for manipulation are used. The purpose is not to load the children with facts, but to arouse their curiosity and beget in them inquiring habits of mind. In the high-school department, systematic scientific instruction is begun for the purpose of developing careful habits of experimenting, observing, and reasoning. Familiar objects or home-made apparatus are preferred for the experiments, both because most of the high schools are not in a position to purchase elaborate apparatus, and because they are believed to be more fit for the purpose. The apparatus in the markets is considered insufficient, "because most pupils of high-school age fail to comprehend the machines, and their minds are confused by them with reference to the principles." The pupils are taught to construct their own apparatus so far as there seems to be educational value in that kind of work; and in most cases such constructions have fulfilled their purpose better than the conventional apparatus. They are not intended to illustrate the apparatus of the markets, or to serve as a cheap substitute for it, but to illustrate scientific principles, for which imitations of "show-case" apparatus are not required. Of course, no attempt is made in this system to teach the whole of science or to cram with facts; but "to show the pupil how to study nature so that through life he may go on to acquire knowledge." Mr. Woodhull's conclusion is that "patience and a love for the work are the most essential qualifications for the teacher; with these and with freedom from unnecessary restraints, however meager other equipments may be, science may readily be

taught in the common schools by experimental methods." The American Institute of Instruction substantially approved Mr. Woodhull's position, and resolved that instruction by experimental methods should be given in schools of all grades; in the primary and grammar grades it should take the form of observation lessons calculated to develop the spirit of investigation; and in the high school "it should undertake to give a thorough training in scientific methods of studying nature rather than a comprehensive knowledge of the whole realm of natural science."

Mounds of the Mississippi Basin.—The mounds of the Mississippi basin are described by Mr. T. H. Lewis, of St. Paul, as being of a magnitude and extent calculated to surprise those who have not examined them. There are thousands of them in Mississippi and Arkansas, and probably thousands in Minnesota. The author's own personal surveys in Minnesota now exceed one thousand, and the localities of at least as many more are known. The mounds in Mississippi—in the bottom-lands—are burial-mounds, and in addition to human remains usually contain earthen vessels and pipes of all sizes and shapes, with occasionally flint and stone implements and articles of copper. The clay mounds of Arkansas and of the bluffs along the Mississippi seldom contain any implements or pottery. Temple mounds are always associated with mounds of other forms, and are never isolated. They have approaches or graded roadways built to the summit, and generally have aprons or terraces on their sides. Smaller mounds having the same forms were used for burial purposes. Platform mounds are another class of temple mounds, and have from one to four approaches. Some of them are also known to contain human remains. Of a class of mounds called hearth mounds the purpose is difficult to determine. They hardly ever reach four feet in height, and the hearth is covered with earth from three inches to two feet in depth. The hearths vary in thickness from one and a half to thirteen inches. The low flat mounds of Minnesota and Dakota are often regarded as the remains of dwelling-houses of the aborigines. The theory is that poles were set up and sods were afterward placed upon the outside; and that the poles having rotted away, the structure fell to the center, and in the course of a few years the top became leveled by the accumulation of dust and vegetation, so that a mound was formed. The Indians used the mode of structure described; but it could hardly have been applied in these mounds, for such a structure, having once fallen, would have become an irregular mass with a concave top, and an opening on the side where the entrance had been — presenting a different appearance from the mounds. None of the mounds of Minnesota, in the author's opinion, were suitable for use as the base of *pueblos*; and he finds no evidence that the large flat mounds of the lower valley were of that character.

The Australasian Scientific Association.—The Australasian Association for the Advancement of Science met in Melbourne early in January. Baron von Mueller was president. The roll of membership included a thousand names, and more than six hundred were in actual attendance. The president's address dealt with the past and future of Australasian science; and the addresses of the presidents of sections were in many cases on subjects of particular interest in Australia. The most important of the committee reports was that on the census of the known minerals of the Australian colonies. A project for establishing and endowing a central biological station at Port Jackson was started. A report was presented on the Polynesian races and Polynesian bibliography. New special committees were appointed to investigate and report on the subjects of wheat-rust; the manner of laying out towns; the preparation of geological maps; the arrangement of museums; the fertilization of figs; Australian tides; and the present state of knowledge of Australasian paleontology. The next meeting is to be held in Christ-church, New Zealand, with Sir James Hector as president and Prof. Hutton as secretary; and the next in Hobart, Tasmania.

An Arizona Squirrel.—A rare squirrel, new to the Territory of Arizona, is described by Mr. Edgar A. Mearns as the round-tailed spermophile (*Spermophilus tereticaudus*, Baird). It is the most abundant and

characteristic mammal of the torrid, sandy, desert region south of the Gila River, where it lives in immense colonies in chambers excavated under the greasewood-roots. Such sites seem to be selected for the sake of the support afforded by the fine roots of the greasewood for the domes of their habitations. Without some such support the light and loose soil would cave in at once. Large, low mounds are formed over the burrows in which many holes are provided for ingress and egress. In some parts of Arizona these mounds are frequently seen in open, grassy places, and are usually large and high. The animals are shy; they sit up erect at the entrance of their burrows, like prairie-dogs, and like them dodge in at the sight of a stranger. When surprised away from home they try to skulk unobserved to their holes, nervously glancing at the observer. But they become less shy when accustomed to the neighborhood of man. Mr. Mearns adds to his description in curiously learned language which becomes expressive when translated, that "although eminently fossorial, this animal is endowed with latent scansorial proclivities, which are brought out by the sight of food in elevated situations. In other words, they will climb for mesquite-beans."

The Circle of Civic Evolution.—The modern, civilized state is developed, in Mr. John A. Taylor's view, as expressed in his address on its Evolution, from the germ that lay dormant in the rude elements of government that existed in the past—as the Cologne Cathedral, completed only a few years since, has been built in exact fulfillment of the conception of its unknown architect, six hundred years ago. Our American commonwealth, based on the idea of government by the governed, expressed at its birth the highest type to which the state had then evolved. This evolution, from all the attempts at government in the past, has been inseparably accompanied and verified by the continual uplifting and expansion of manhood as a type. Now we find that evils have been developed within our system which threaten its existence, and appear to be dragging down "manhood as a type": they are most conspicuously manifested in the cities, but exist through the whole political body. They are very numerous, but may be generalized under the terms corruption and bossism. Public interests are made an affair of trade, and are openly used for private advantage; and no measure, however important and beneficial, can be secured unless it can be made profitable to the ring of practical politicians. Everything has fallen into the hands of the leaders of the great political parties, who manage the parties and the community alike at their will, while the people appear to look on helpless. If the people are competent to govern, as our Constitution supposes, why do they not right matters? Mr. Taylor's answer to this question is not wholly confident; but he suggests that the rapid advance we have gone through in wealth and invention, with our constantly changing environments, have engendered problems of which the framers of our Constitution never dreamed; and that, having delegated our right of choice to the politicians, we have reached an epoch in the evolution of the state when the art and science of government are left in abeyance, and the best thought and effort of our time are given to other pursuits. Yet he has hope for our government, and offers the suggestion that "at some time, perhaps in the far-distant future, the state will have evolved into an entity of purely delegated as distinguished from representative powers"—which will look much like a return to monarchy and lords.

Judge-made Law.—Mr. Rufus Sheldon, in his paper on the Evolution of Law, argues that so much of the law as is defined by the decisions of the courts is made by judges. "That judges make law," he says, "is not explicitly stated in the text-books. In fact, it is not generally admitted that they have any part in law-making; the theory being that there is somewhere a store of ready-made law, consisting of rules and precedents, where the judges somehow find what they want after the lawyers have searched for it in vain, and then expound and apply it with plenty of comment and *obiter dicta*, but no addition." But it often occurs that, if any determination of right or liability is made, it must be made by the court; as must happen in every instance where judgment is given in a case different from any to be found in the reports—and just in proportion

to the difference of the circumstances from those of any previous case is the amount of new law made. So the law increases, following civilization as it advances, till at last the total becomes an enormous bulk of judge-made laws; the result of the progressive deduction of rules and principles by a process of distinguishing by small variation, variations from previous cases similar, but not identical; so that, when a decision is made, some increment is added to the body of the law, or substitution of new for old is made, even to such a degree that at last, by the slow process of disintegration, the old law is reversed. "A distinctive characteristic of legislation is that it is supreme over all other methods of law-making. Its advantage is that it can make the will of the people effective much more directly and expeditiously than the other agencies. Many are the cases in which legislation has swept away the cobwebs of legal subtlety, simplified technical laws, and cleared from the path of progress the obstacles of precedent and form."

Tests and Characteristics of Rabies.—Rabies, says Dr. Armand Ruffer, is a specific infectious disease, the first origin of which is unknown. But we know that nowadays it never occurs spontaneously, and that, wherever it appears, it may be traced to the bite of a rabid animal or the accidental introduction of rabic virus through a scratch or cut. Climate seems to have no influence, or very little, on its production. That heat has little to do with it is shown by the fact that it occurs in cold as well as in hot climates. In temperate climates, cases occurring among dogs appear to be as common in winter as in summer. Cruelty may also be excluded as a cause of rabies. Dogs may be teased and provoked to bite in anger, but, though mad dogs, they are not rabid dogs. The chief propagator of the disease is the dog; but he does not always, at first, exhibit the symptoms regarded as characteristic of it. He is not usually afraid of water, and the first symptoms, instead of signs of fury, usually simulate an increase of affectionate sentiments. Even at this stage, however, the saliva already contains the virus, and is dangerous. Later on, the victim becomes sullen and morose, with a very characteristic bark, biting every dog he comes across, and frequently runs away, snapping at animals or men as he meets them, till he dies exhausted, perhaps sixty or seventy miles from home. The dumb variety of rabies, which is characterized by the symptoms of paralysis, is equally common and dangerous with the furious form. The virus is the same, but gives rise to different symptoms. Rabies is also propagated by wolves where they are numerous; and it may be met with in foxes, horses, sheep, and cattle which have been bitten by rabid animals, but is seldom communicated from them. The cat is dangerous, but not so dangerous as the dog, because her disposition is to seclude herself. Some erroneous notions prevail as to the manifestations of the disease in man. As a matter of fact, in many cases the patient is calm and conscious, and attacks of excitement are rare. The foaming at the mouth is caused by inability to swallow the saliva. The changed voice is a result of dryness and spasms of the throat. A patient may occasionally bite the attendants during a paroxysmal attack of fury, but in the majority of cases he does not try to injure those near him, and hardly ever tries to bite. Sometimes there are no attacks of excitement, while the affectionate sentiments are often greatly exaggerated. The supposed fear of water is really only an inability to drink, the reaction of which may induce spasms of the throat. The majority of persons who die of hydrophobia die within four months, and ninety-nine per cent of them within a year, after the introduction of the poison. Cases of persons who recover after the first symptoms of the disease appear are extremely rare, if there are any. Of remedies there are none that are reliable, unless M. Pasteur's comes from the test triumphant.

Interesting Geological Formations in Kansas.—The March number of the Bulletin of the Washburn College (Kansas) Laboratory of Natural History consists of a paper by F. W. Cragin on the Cheyenne Sandstone and the Neocomian Shales of Kansas. The Cheyenne sandstone, resting unconformably on the Triassic of a few counties of southern Kansas, is so called for the present in default of precise knowledge of its stratigraph-

ic and paleontological equivalency. It contains fossils related to those of the Purbeck dirt-beds of England. It is overlaid by the Neocomian, which extends also into other counties, and is distinguished by its horizon of dark, slate-colored shale. This formation was first remarked by Prof. Jules Marcou in the Indian Territory some thirty-five years ago, but has received little attention, and is still very imperfectly known. Its thickness is variable, but probably nowhere exceeds one hundred and fifty feet. It is the same as the formation called by some geologists Comanche; but the term Neocomian is preferred on account of its referability to a European chronological equivalent.

The Work of a Complete State University.—The Coming of Age of State Universities is the title of the charter-day address of President T. C. Chamberlin, on the twenty-first anniversary of the University of Nebraska, in which the work of the complete State University is delineated. Such an institution will educate all its constituents in all varieties of useful knowledge—with a view to the common rather than to the individual good; it will endeavor to develop scholarship in its highest and most refined expressions, as well as in its more material and commercial phases—not for the sake of the scholar as such, but for the ultimate refinement and elevation of the common life of the whole people; it will promote a generous spirit of inquiry, a trained habit of investigation, an attitude of impartiality toward evidence, and a supreme regard for truth; will endeavor to serve all other parts of the public educational system by furnishing fresh knowledge, amply trained teachers, and the inspiration of higher educational opportunities; and will encourage, as an inherent factor and ultimate end of its efforts, those sentiments of regard for the common interests, those patriotisms of every-day life, that constitute the soul of superior citizenship.

Four Commencement Days.—In human life, says Dr. J. M. Bodine, in a valedictory address to the graduating class of the Medical Department of the University of Louisville, are four great commencement days—when we begin to be, when we begin to learn, when we begin to practice, and when we enter the existence beyond the grave. On the third of these days the author advises his students, if business does not come at once—"devote yourself to reading, and use every opportunity to do something professional. . . . See every operation, autopsy, and pathological specimen you can. Study botany in the fields, chemistry in the laboratory, and look into the invisible with your microscope. If seen thus engaged, the people will credit you with seriousness in your profession, and your employment, without patients, will be your best advertisement. . . . The route to preferment does not lie through the *salons* of society, the village sports, and is far away from the drink-shop. By complacency in yielding to the social and sportive, you will get the name of 'good fellow,' but when life is trembling in the parted scales sobriety and skill are at a premium. You must learn to labor and to wait. But, while waiting, work for knowledge and watch for opportunity. Win by application; woo by merit. . . . Be able to do something better than those around you, and the call to do it is certain."

Mountains of Arizona.—The region of the San Francisco and Mogollon Mountains of Arizona and New Mexico, as described by Dr. H. H. Rusby, comprises an elevated, open, somewhat barren table-land; a still more elevated forest belt; and a low, desert, mostly sandy plain. The table-land is traversed by a number of profound cañons, with precipitous walls a mile or more in height, and by many others of less depth, and is a never-ceasing source of surprises to Eastern visitors. "During the greater part of the year the surface is dry and desolate, of an ashy-gray color; but immediately upon the occurrence of the annual rains it changes with marvelous rapidity. Within three days after the first important showers, a distinct tinge of green is perceptible. In a week the surface is of an almost uniform light green; and in from ten days to two weeks it presents an appearance of great luxuriance. From this time on, until the occurrence of killing frosts, it is a paradise for the collector." The San Francisco Forest consists almost wholly of the *Pinus ponderosa*, and is one of the most beautiful for-

ests in existence, its effect being heightened by contrast with the neighboring deserts, from which it must be entered. It is also a very important timber resource. The San Francisco Mountains, in which it rises, have an elevation of about nine thousand feet, or some twenty-five hundred to three thousand feet above the general level, and give strikingly apparent evidence of their volcanic origin. Everywhere through the forest we encounter beautiful open parks, from a few acres to several miles in area; and in these the permanent water-supplies are usually found. The soil underlying the forest consists, for the most part, to a great depth, of loose volcanic rock, upon the surface of which no stream can form a permanent bed. The water-courses, therefore, are far beneath the surface, but reappear occasionally to form living pools of water, often a hundred yards or more in diameter. But during the heavy rains even this porous soil is not sufficient to absorb the entire fall of water, and it runs off through the hollows, washing out the loose material to form ravines and small cañons.

Ancient Peruvian Cloths.—Some textile fabrics of ancient Peru, in the collection of Mr. E. A. Barber, of Philadelphia, as described by Mr. W. Holmes, attest the high standard of taste and mechanical art which that people had reached. Most of the cloths and ornamented garments were wrapped around the dead, and may now be unfolded from the mummies. Others are contained in rolls, baskets, nets, and vases. The articles were chiefly of wearing apparel, and included caps, richly colored bands, and pendent ornaments for the head; mantles, shirts, girdles, sashes, and a variety of wraps for the body; braided sandals for the feet; blankets, hangings for doors and walls, shelter-cloths, ceremonial fabrics and banners, mats, baskets, bags, slings, nets, and other articles. Elaborate ornamental figures were woven into the cloths, and many were furnished with textile appendages. Some of the articles were woven whole, but it was customary to weave a garment in parts which were afterward stitched together. There was no cutting and fitting, or "weaving by the yard." All the specimens are purely American in character, with no suggestions of Spanish or other foreign influence. Animal and vegetable forms appear in the decorations, but animal forms predominate. The colors of the figures usually bore no reference to the colors of nature, but were chosen for their effect in the decoration. Great cleverness was shown in introducing the irregular forms of nature into geometric outlines without destroying them. A human figure "decked in plumes and clothed in garments of elegant patterns and varied colors" introduced in "a magnificent piece of gobelins," "is a triumph of skill and taste." In many pieces the figures were shown as transparencies when held up to the light. The people were exceedingly fond of fringes, "and some of their tasseled garments are marvels of elaboration." Great skill was shown in the manufacture of very attenuated articles, such as bands and cords. Animal figures were woven or knitted in the round, and colored in fair and close imitation of nature. Embroideries have been found of excellent quality and most pleasing design. Devices were used in dyeing, by means of which spots arranged in simple patterns were left uncolored; and painting on fabrics was extensively practiced.

Nursing as against Artificial Feeding.—Soxhlet remarks that, according to Lister's experiments, cow's milk, while in the udder, is free from those organisms which cause its decomposition after milking. The substances which cause fermentation of milk come from the outside, from the air or from matters with which it comes in contact. So, likewise, human milk, while in the mother's breast, contains no generators of fermentation. By suckling, the mother's milk is transmitted almost directly into the digestive organs of the child. In natural nursing, then, the child is fed germless milk; but, by the artificial method, with milk tainted by substances causing fermentation, and which frequently has already entered into a state of decomposition. The difference in the nature of this food as directly and as indirectly given is illustrated by the fact that calves fed from the pail, whether on the milk of the mother cow or on mixed milk, frequently suffer from diarrhœa during the first weeks, the best remedy against which is to allow them to suck the cow directly. We are

brought to the conclusion that, within certain limits, the substance of the food is of comparatively less importance than the conditions and manner of feeding and the degree of pollution through germs of fermentation.

Requisites of a Real Education.—In an address before the Teachers' Association of the McGill Normal School, Montreal, Prof. Wesley Mills, explaining his educational creed, assumed that the need of knowledge, or realization, is infinitely greater than the needs of expression, as witness the whole creation below man. An individual may be educated, though unable to read a sentence, write a line, or add up a column of figures. As a matter of fact, many men have become eminent among their fellows who could not do any of these things. Why has this been so? The reason is plain. These men understood the forces of nature, though they could not in all cases have stated their knowledge in our conventional forms of expression. The art and science of expression should be taught in schools, but should be subordinated to the acquisition of the knowledge of things. The moral and social nature of man should receive greater attention. The teaching of religious doctrines and the observance of religious forms are not practical in the public schools, but ethics by precept and example should be prominent from the day a child enters the school. A reverence for all kinds of truth should ever be impressed. Only one system of education—the Kindergarten—has ever met the nature of the child even fairly. The laboratory of the college is only the modified Kindergarten. Why is not the public-school teaching more like one of these? Because we have mistaken forms for knowledge and words for things, to a lamentable extent. "As our schools are now constituted, I must deliberately declare it as my conviction that they tend rather to quench than to excite a love for nature and a real knowledge of things, and to disgust young minds thirsting for a contact with realities. . . . I have known children that did not go to school till seven years of age, who had prior to that period learned to be good observers of what was going on around them, lose all love for natural objects after being at school a couple of years; and I do also know to my sorrow that many of the young men that enter our colleges neither know how nor care to observe. They prefer not to look Nature directly in the face, but try to see her through the medium of books, lectures, etc., and for this our school system is largely responsible." One of the remedies proposed for this evil is the simplification of the too ambitious school programmes. Abstract subjects, like history and grammar, should be left for future years. They take up the time that might be devoted to developing the intelligence through cultivation of observation and stirring the mind with the results of the exercise of the senses. Childhood is not the period of life for developing abstract notions, but for acquiring concrete ones. While in the abstract it is true that a knowledge of French, Latin, Greek, etc., may help to make one a better English scholar, the idea that an amount of these languages that would be of any value can be taught to the average pupil, without the neglect of other important work, is a delusion. The school should aim to enable the child to speak and write its mother-tongue readily, clearly, and elegantly. This will not be accomplished by teaching English grammar or foreign languages, but by contact with good models and practice. "Time is now frittered away on so many subjects that nothing is well done, and with the most disastrous effects on the habits of the learner. Our schools are dreadfully bookish."

Scientific Missions in the Olden Time.—The institution of missions abroad with scientific aims began in France, according to Dr. Henry, practically in the reign of Francis I. Among the earlier ventures of this class was that of the apothecary to Henri IV, who went all over the globe in search of the peculiar products of each country, especially medicinal and food plants. Earlier than he was the explorer who went to Brazil to study dyeing-woods. Among the most famous of the expeditions were those of Condamine, Dombey, Bougainville, and La Pérouse. There are still in the archives of the Ministry of the Marine copies of the instructions given to travelers and navigators in past centuries—"positively models of their kind, which could not be followed too

closely now." A botanical collection made by Paul Lucas, in the reign of Louis XIV, is mentioned by Prof. Bureau as still existing in the Museum of Natural History in Paris. Tournefort was sent by this king on a botanical expedition to the Levant, with very precise instructions—among others, to collect and observe the plants mentioned by the ancients. He formed a complete herbarium; and the artist Aubriet, who accompanied him, brought back a large collection of colored sketches. Both of these are preserved in the museum.

Primitive Marital Customs.—The proverbial hostility of a man or woman to a mother-in-law may be a survival from a social custom of our primitive ancestors similar to one which exists now among uncivilized peoples. This is the quaint and somewhat comic point of barbaric etiquette between husbands and their wives' relatives, and *vice versa*; they may not look at one another, much less speak, and they even avoid mentioning one another's names. Among the avoidance customs cited by Mr. E. B. Tylor, in a recent essay, is that described by John Tanner, the adopted Ojibwa, who tells of his being taken by a friendly Assinaboin into his lodge, and seeing how, at his companion's entrance, the old father-in-law and mother-in-law covered their heads with their blankets till their son-in-law got into the compartment reserved for him, where his wife brought him his food. Another comes from Australia. Mr. Howitt relates that he inadvertently told a native to call his mother-in-law, who was passing at some little distance; but the black fellow sent the order round by a third party, saying reproachfully to Mr. Howitt, "You know I could not speak to that old woman." This custom is not a rare one, for Mr. Tylor finds it to be practiced by sixty-six peoples in various regions, or more than one sixth of the peoples of the world, and he points out a relation between it and the customs as to place of residence after marriage. Another odd practice of certain savages is that of naming the parent from the child. Thus when Moffat, the missionary, was in Africa, he was spoken to and of, according to native usage, as Ra-Mary—i. e., father of Mary. Among the Kasias of India, Colonel Yule found the same rule; for instance, there being a boy named Bobon, his father was known as Pabobon. There are above thirty peoples spread over the earth who thus name the father, and, though less often, the mother. Mr. Tylor finds this practice to be closely connected with the custom of the husband residing in his wife's family. The *couvade*, which has been a favorite subject of ridicule for centuries, consists in the father, on the birth of his child, making a ceremonial pretence of standing in a relation to it similar to that of the mother. He is nursed and taken care of, and performs such rites as fasting and abstaining from certain kinds of food or occupation, lest the newborn should suffer thereby. This custom is known in the four quarters of the globe. How sincerely it is still accepted appears in a story of Mr. Im Thurn, who on a forest journey in British Guiana noticed that one of his Indians refused to help haul the canoes, and on inquiry found that the man's objection was that a child must have been born to him at home about this time, and he must not exert himself so as to hurt the infant. In the Mediterranean district the *couvade* has prevailed even into modern times. In the Basque country, Zamacolo, in 1818, mentions as but a little time since that the mother used to get up and the father take the child to bed. "Knowing the tenacity of these customs," says Mr. Tylor, "I should not be surprised if traces of *couvade* might be found in that district still." He accepts the interpretation of Bachonan that the *couvade* was originally an acknowledgment of paternity.

Ancient Men of the Potomac.—Prof. Otis T. Mason's survey of the archæology of the Potomac region covers that part of the valley which is situated below the rapids of the several tributary streams that mark the limits of tide-water. In the fresh-water portion of the lower Chesapeake drainage—the region between salt water and the cataracts—stone implements are found in the greatest profusion. It is easy to account for this when it is remembered that the country furnished abundant natural fruit supply. To one accustomed to exploration among the mounds of the Ohio Valley or in the West Indies, the stone implements are in appear-

ance disappointing. While here and there polished axes are found, the polished implement is the exception, not the rule, especially on higher ground. Again, comparing the chipped implements with those from regions abounding in flint, obsidian, and the finer varieties of the silex group, a large collection of them has a somewhat rude appearance. All this is due, however, to the material. The ancient Potomac dweller was restricted to bowlders of quartzite found in quantities inexhaustible all over his area, to veins of milky quartz outcropping here and there, and to an occasional quarry of soapstone. Types of pottery and impressions of woven fabrics contribute to our knowledge of the degree of advancement which the people had reached, and cast light on the tribal distributions. The most serious problem that faces the archæologist in this area has been proposed by Mr. Thomas Wilson, in the evidence of the existence of two periods of occupation—the one Palæolithic and ancient, and the other Neolithic and modern. While the camp-sites along the water-courses yield abundance of finely chipped arrow-heads, spear-heads, knives, polished implements, soapstone vessels, and pottery, the hills back from the river are wanting in the smaller, finer forms, but abound in coarser, flaked *artefacta*, mixed with broken implements and spalls.

The American Association.—The thirty-ninth meeting of the American Association will be held in Indianapolis, beginning Wednesday, August 20th. The general sessions and the meetings of the sections will be held in the new and commodious State-House, where also will be the offices of the Local Committee and of the Permanent Secretary. The hotel headquarters of the Association will be at the Denison House, and the preliminary meeting of the Council will be held there on Tuesday, the 19th. Interest will be added to this meeting by the fact that it will mark the fiftieth anniversary of the organization of the Association of Geologists and Naturalists, the parent of the American Association. The sessions will continue till Tuesday evening, the 26th, and a meeting of the Council will be held Wednesday, the 27th; Saturday, the 23d, will be given to excursions; and the excursions, after the close of the meeting, will extend to August 30th.

The officers-elect for the meeting of 1890 are:

President. — George L. Goodale, Cambridge, Mass.

Vice-Presidents.— A, Mathematics and Astronomy—S. C. Chandler. B, Physics—Cleveland Abbe. C, Chemistry — R. B. Warder. D, Mechanical Science and Engineering—James E. Denton. E, Geology and Geography—John C. Branner. F, Biology — C. S. Minot. H, Anthropology—Frank Baker. I, Economic Science and Statistics—J. Richards Dodge.

Permanent Secretary.— G. W. Putnam.

General Secretary.—H. Carrington Bolton.

Secretary of the Council.—James Loudon.

Secretaries of the Sections.—A, Wooster W. Beman; B, W. Leconte Stevens; C, W. A. Noyes; D, M. E. Cooley; E, Samuel Calvin; F, John M. Coulter; H, Joseph Jastrow; I, S. Dana Horton.

Treasurer.—William Lilly.

Auditors.—Henry Wheatland, Thomas Meehan.

A Papuan Bridge.—A native suspension bridge, crossing the Vanapa River, is described by Sir William MacGregor, British Administrator of New Guinea, as being, considering its locality and the primitive situation of the inland natives of the district, a remarkable structure. Advantage is taken of the narrowing of the river by the projection of a rocky point, so that the bridge is only about seventy yards long. At one end it is chiefly supported by a large banyan-tree, whence it starts at an elevation of about fifty feet above the pool below. It descends then in mid-stream to about twelve or fifteen feet from the water, and rises to about twenty feet on the right bank. It is then suspended to a tree not strong enough to hold it firmly. The tree is, therefore, supplemented by a post put in the ground, and this is again strengthened by a cross-bar against the tree, fixed by stays extending backward to trees behind. The material of the structure is rattan cane. Fifteen canes are used to form supports, those not long enough to cross the river having been built up by knotting. The floor of the bridge is formed of four of these canes. Above the floor are two "guard lines" on

each side at intervals of two feet six inches and two feet three inches, kept in position by split cane worked in a kind of basket-fashion. The whole would present, in transverse section, nearly the shape of a somewhat rounded V about five feet high and three and a half feet wide at the top. The top strands are kept apart by a cross-stick, the ends of which are tied to the top of each strand. Suitable platform approaches have been built at the ends, and the whole structure is strong and graceful.

Fine Art in the Workshop.—In a discussion of the relation of the fine arts to the applied arts, Mr. Edward C. Robins insists that the workshop is the place for applying those principles of beauty in art which are not taught there, but may be taught in the technical school, and which are necessary to give the worker the intelligence required to enable him to profit by the opportunities which the workshop alone adequately supplies to the handicraftsman. To secure the inculcation of these principles the natural and instinctive love of children for imagery, for stories, for penciling and coloring, for deft fingering should never cease to be cultivated; and every school should teach drawing as it teaches reading, singing, or ciphering. The free use of the pencil is of incalculable value in every sphere of life. Elementary knowledge is not enough, and the process should be carried on till proficiency results; and this can not be in the arts connected with architecture unless it culminates in complete mastery of decorative design and drawing from natural forms and the living model, as well as the practice of geometry and perspective. The pre-eminence of France in art generally, and its application to industry, seems to have resulted from the recognition of this important preliminary training.

Local Magnetism and Geological Structure.—The Relation between the Geological Constitution and the Magnetic State of the United Kingdom was discussed in a paper at the British Association, by Prof. A. W. Rücker and T. E. Thorpe. Having noticed certain abnormal variations in declination depending on the geological character of the district as engendering local or regional disturbing forces, the authors outlined two principal theories which had been proposed to account for the phenomena. Many igneous rocks and wholly basaltic rocks contain magnetic oxide of iron, and the deviations of the needle may be explained by the presence of such rocks, either visible on the surface or concealed beneath it. The other explanation associates the deflections of the needle with disturbances of the earth's currents of electricity produced by irregularities in the geological constitution of the country, especially with geological faults. The authors were of the opinion that on the whole the theory of the action of magnetic rocks agrees best with the observed facts; and they showed that the United Kingdom can be divided into a number of magnetic districts, in which the directions of the disturbing forces are evidently closely connected with the geological constitution.

The Eyes and Headaches.—Headaches are usually associated with disorders of the system or of important organs. It is pointed out, however, by Dr. J. J. Chisholm, in a paper on Persistent Headaches and how to cure them, that a large number of head discomforts occur in which no acute inflammatory condition exists, and no fault can be found with the general health. In many of these cases, especially in such as are relieved by stopping work, the cause of the disorder may be traced to the eye. This may be the case even when no pain is felt in the eye itself, and where no weakness of vision has been detected. The true headache eye is known as an *astigmatic* one, or one in which the light, through defective change of the lenses, fails to be concentrated to a point on the retina. It is a frequent product of the schools as they are now managed. Aside from abandoning the use of the eyes, which is impossible, the only remedy for the astigmatic headaches is found in wearing suitably chosen glasses.

Musical Visions.—The story is told in Nature of a young woman who has distinct visions of various objects at the sound of different musical instruments. The playing of the oboe calls to her eye a white pyramid or obelisk running into a sharp point, the proportions of which vary with the qualities of

the note. All the notes of the cello, the high notes of the bassoon, trumpet, and trombone, and the low notes of the clarionet and viola suggest a flat undulating ribbon of strong white fibers. The tone of the horn calls up a succession of white circles of graduated size, overlapping one another. The circle and the ribbon float past her horizontally, but the point of the obelisk seems to come at her. In an orchestra, when the violins strike up, after the wind band has been prominent for a time, she sees often a shower of bright white dust or sand. If she knows the scoring of a piece well, the various effects slightly precede the instrument they belong to; but the objects are vague and faint till the sound begins. Sometimes, if an oboe passage has an intense or yearning character, the white point comes so near her, and moves so rapidly, that she thinks it must wound her.

Who Should study Chemistry. — In an article in which it is shown what small remuneration is obtained for ordinary chemical work in England, the editor of The Chemical News says: "It must not, however, be supposed that we are seeking to dissuade the young from the study of chemistry altogether. To three classes, who we would fain hope are becoming more numerous, we must recommend it most strongly. In the first place, to all who aim at reaching something higher than a mere board-school grade of mental culture, we should recommend it, quite irrespective of possible material benefits, as a means of intellectual training. Chemistry teaches us the important arts of close and accurate observation, and of drawing correct inferences from the facts recognized. These important arts can never be mastered by the most prolonged study of classics and mathematics. Hence, if we regard education as intellectual discipline rather than the mere absorption of a number of facts, we shall find some one of the branches of natural and physical science absolutely essential and indispensable. And under most circumstances chemistry will prove the most appropriate subject. Another class which we should like to see largely recruited consists of men in independent circumstances who have the leisure needed for taking in hand those many scientific problems which are often neglected because they are not immediately remunerative. Such men too commonly waste their time in dissipation, in the pursuit of more wealth, or in making mischief. Now, if they possess the needful ability, we had much rather see them at work in the laboratory. The last class to whom we would especially recommend a thorough study of chemical principles are those who are looking forward to employment in the chemical arts, whether as proprietors, managers, foremen, etc. It is a misfortune when men who occupy such positions depend merely upon rule of thumb and traditional recipes. If these three classes do what we believe is their duty, our national manufactures and our national habits of thought will alike undergo a needed improvement."

Marriage Ages in England.—For the last seventeen years the persons who have married in England have been older each year. In 1873 the men who married averaged 25·6 years of age, and the women 24·2; in 1888 the averages were respectively 26·3 and 24·7 years. The mean age at marriage in the professional and independent classes is seven years more advanced for men and four years more advanced for women than among miners—in fact, generally speaking, the higher the class the later the age at which marriage is contracted. These results were presented to the Royal Statistical Society in a recent paper by Dr. William Ogle, who said further that more persons remain permanently celibate in the upper than in the working classes. He had found that fewest men abstained altogether from matrimony among shopkeepers, to whom wives were almost a necessity. Next to them came the mechanics and laborers, while the professional and independent class had a proportion of permanent bachelors far above the rest.

Healthful Walls and Ceilings.—A requisite to the healthful condition of ceilings and walls, according to Prof. R. C. Kedzie, is the preservation of their respiratory quality, or of a degree of porosity that will permit a free transpiration of air through them. While this exists unimpaired, impurities lodging upon them are naturally consumed, and they remain clean and wholesome; what-

ever tends to obstruct transpiration promotes the accumulation of impurities. For this reason, even paint, though it may be intrinsically harmless, is objectionable. Paper is positively objectionable, because itself collects impurities and retains them; the substances with which it is prepared and decorated do the same; and the paste with which it is attached responds to all dampness and atmospheric influences, and readily becomes moldy. Kalsomine is faulty, because it is prepared with glue, and that, besides stopping the pores in the plastering (or "strangling the wall"), is liable to decay. No wall coating can be more healthful than a lime-wash. But, since that is inconvenient on account of its rubbing off, an excellent substitute is recommended by Mr. M. B. Church in calcined plaster of Paris, which hardens at once, forming a fixed shell of perfect porosity.

NOTES.

A CORRECTION.—By a slip of the pen which also escaped notice in the proof-reading, Prof. Weismann is made to say twice in the second paragraph of page 357 of our July number "cerebellum" where "cerebrum" was intended. Read—"if, again, we were able to remove all the other parts of the cerebrum," etc., and "with the rest of the cerebrum was taken, etc."

THE meeting of the British Association for 1890 will be held at Leeds, September 3d to 10th, under the presidency of Sir Frederick Abel. The sectional presidents will be: A, Dr. J. W. L. Glaisher; B, Prof. T. E. Thorpe; C, Prof. A. H. Green; D, Prof. A. Milnes Marshall; E, Sir R. Lambert Playfair; F, Prof. Alfred Marshall; G, Captain A. Noble; H, Dr. John Evans. Evening addresses will be given by Mr. E. B. Poulton on Mimicry; Prof. C. Vernon Boys on Quartz Fibers and their Applications; and Prof. Perry will lecture to the working classes on Spinning Tops.

A NEW food is described in the Kew Bulletin as used by the poorer classes in northern India. It is called *phog*, and is made from the flowers of the plant *Calligonum polygonoides*. They are eaten mixed with flour, or separately with salt and condiments They are rich in nitrogenous compounds, and somewhat resemble the seeds of the edible amaranths and buckwheats, only that in them sugar replaces starch.

A VISIBLE illustration of the figures produced by sound-waves has been devised by Mrs. Watts Hughes, in what she calls "voice-figures." They are practically Chladni's figures, produced in a viscid medium. Semi-fluid paste is spread over an elastic membrane stretched over the mouth of a receiver. A single note sung into the receiver throws the paste into waves and curves. The patterns formed are photographed immediately after production, or are transferred as water-color impressions while the membrane is still vibrating. Perhaps the most interesting figures are the "daisy forms," in which "the number of petals increases as the pitch of the note that produces them rises."

MR. ALBERT KOEBELE, who was dispatched to Australia under the direction of the Entomologist of the Agricultural Department to obtain natural enemies of the "fluted scale" of the orange (*Icerya purchasi*), brought home an insect, the cardinal vedalia, which has proved very efficient. It has already multiplied to such an extent as to rid several groves from *Icerya*, and is looked upon as promising immunity in the near future for the entire State of California. In fact, Dr. Riley fears that it will do its work so well as to leave no field for other insects which Mr. Koebele procured, and which it is desirable to cultivate for the sake of having a variety.

IN a paper in the Connecticut Pharmaceutical Association, Mr. D. G. Stoughton appears to have arrived, by a way of his own, at the conception of the identity of electricity with the other physical forces, heat and light, now demonstrated by Mr. Hertz's experiments. He regards them as resultants of the obstruction of ether motion by matter. Molecular motion, intense within the sun, is supposed to be transformed at the confines of the gaseous envelope surrounding that body into ether motion, which, passing through the ninety million miles of ether to the confines of our atmosphere, is obstructed by the molecules of atmosphere, and gives rise, according to the measure of the obstruction, to electricity, light, and heat.

HOLMGREN'S test for color-blindness is the one recommended by those who have given the subject most attention. There are three parts to the test, which consist in picking out from a lot of wools all those skeins that match given ones in color. A pale green is the test-color first used, then a dilute purple, and finally a bright red. The person is not required to *name* any colors, as this is a different matter from distinguishing them.

A WRITER in Le Monde de la Science et de l'Industrie recommends, as an excellent insoluble plastic material, a mixture of cheese or casein or albumen and lime, well worked up. It is insoluble in hot water. Artistic effects may be obtained by molding, and it is easily colored.

A MODE of filling teeth that has recently been made practical in England is by inlaying porcelain. The cavity is made perfectly cylindrical, and a bit of specially manufactured porcelain is turned to the exact size to fit it. The inlay is then secured in its place with sandarac varnish or very fluid white filling. After this is set, the surface of the inlay is ground to a proper contour and polished. An oblong cavity can be filled by inserting two inlays. Of course, this method can not be used, nor is it specially desirable, for all cavities, but few will deny that a filling which matches the natural tooth in color is far less conspicuous, and more agreeable to see, than the glaring patches of yellow metal, which are only excusable as saving a worse disfiguration.

THE sum of six hundred dollars has been appropriated by the National Academy of Sciences for the construction of apparatus to aid Prof. Cattell in his researches on the time of cerebral operations. With the cooperation of Dr. S. Weir Mitchell, Prof. Fullerton, Prof. Dalley, and others, researches are in progress at the University of Pennsylvania on the rate at which impulse travels in motor and sensory nerves and in the spinal cord, the time of reactions and of more purely mental processes, memory and the amount forgotten in a given time, the time of bodily and mental processes in diseases of the nervous system, and in other directions.

THE effects of steam in the destruction of bacteria do not depend, according to the researches of Von Esmarch, so much upon the temperature as upon the degree of saturation of the steam. If there is air with it, the power of destroying organic germs is very much diminished.

A COMMITTEE has been formed in Paris for the erection of a statue of the late M. Boussingault.

DURING some experiments as to the temperature of snow at different depths, it was found that very little variation occurs in the lowest layer, next the ground, while the temperature of the upper layer is considerably higher.

A NOVEL aspect of bacterial life is suggested by A. de Barry in his Comparative Morphology of the Microfungi. Writing of Béchamp's theory of the microzymes, the author says that these minute bodies not only develop independently after the death of the parent organism, but enjoy an almost unlimited duration of vitality, since they may lie during entire geologic periods in such a rock as chalk, and yet retain the power of development.

DR. R. ASSMANN, in a communication to Das Wetter, names, with especial reference to influenza, as the climatic conditions favorable to the dispersion of organisms in the air: Dryness of the ground and absence of snow; infrequent rain and that light; presence of fogs or low clouds; and predominance of high barometric pressures, with imperfect intermingling between the strata of the air.

CELLULOID artificial eyes are cheaper than those of glass and have a good appearance; but Dr. Meurer, of Lyons, states that after three or four months they are liable to cause serious irritation, probably as a result of some chemical change. He has repeatedly seen this inflammation allayed by simple antiseptic treatment after the removal of the celluloid, reappearing, however, as soon as the old eye was put in again, but remaining absent if a glass eye was substituted.

THE Scientific Publishing Company, New York, announce as in preparation Systematic Mineralogy, based on a Natural Classification, by Dr. T. Sterry Hunt.

THE French Association for the Advancement of Science will hold its nineteenth annual meeting at Limoges, from August 7th to 14th. A number of English scientists have been invited, who will be guests of the municipality of Limoges.

IN a recent article on cyclones, Mr. H. Habernicht shows that, if the globe were covered with water, the general circulation of the air would be very regular. He states as the primary cause of cyclones the obstruction offered to the wind by the continents to the east and west of the Atlantic; and, secondly, the constant high barometric pressure over the continent and in the arctic regions during the winter.

DR. FITCH, former State Entomologist of New York, gives a remarkable instance of the long imprisonment of insects without loss of life. In 1786 a son of General Putnam, residing in Williamstown, Mass., had a table made from one of his apple-trees. Many years afterward the gnawing of an insect was heard in one of the leaves of this table. The noise continued for a year or two, when a large, long-horned beetle made its exit therefrom. Subsequently two more beetles issued from the same table-leaf, the first one coming out twenty and the last one twenty-eight years after the tree was cut down.

SOME recent explorations in the famous Adelsberg cave, Carniola, Austria, show that the Ottaker cave discovered last year is a continuation of the larger one. The exploration was made by a party of Adelsberg citizens and occupied six hours. It was necessary to use a boat several times. The explorers think the cave very much larger than was formerly supposed.

IT is proposed in Paris to name a new street after Darwin.

At a recent meeting held at Madrid, to consider the celebration of the four-hundredth anniversary of the discovery of America by Columbus, a grand committee was elected which will act in concert with the Spanish Government, and a committee previously appointed, and presided over by the Duke of Veragua, a lineal descendant of Columbus, and the present Minister of Public Works. It is proposed that the centenary shall be celebrated, if possible, at Madrid. Genoa is also making preparations to celebrate the same event.

The annual address of Mr. Charles F. Cox, as President of the New York Microscopical Society, is published in the Journal of the Society for April, 1890. The subject is Protoplasm and the Cell Doctrine, and the essay is a historical account of the development of scientific views in this field.

A bill has been introduced by Sir Henry Roscoe in the British House of Commons authorizing the Board of Managers of any public elementary school to provide technical instruction for its pupils at any suitable place, attendance at which shall be deemed to be attendance at the public elementary school.

The influence of ground-water and shallow wells in relation to public health is discussed in a recent paper by Dr. W. B. Featherstone. A considerable number of diseases are shown to be associated with defects in ground-water and its impurities, as well as of shallow well water; but the exact amount of influence exercised by these properties on the production and spread of disease has yet to be measured.

Wood-stone is the name of a new compound material composed of sawdust and calcined magnesia. The mixture, having been well worked up with water, is put into molds and pressed into whatever shape may be desired. It is incombustible and impermeable to water, is susceptible of a fine polish, and is adaptable to numerous uses.

OBITUARY NOTES.

Dr. Herman Shultz, Director of the Observatory and Professor of Astronomy at Upsala from 1878 to 1888, died in Stockholm May 8th. Of his numerous astronomical publications, the best known is Micrometrical Observations on five hundred nebulæ, which was published in England in 1874.

Prof. W. K. Sullivan, President of Queen's College, Cork, well known as a chemist, died May 12th, aged sixty-eight years. He succeeded Sir Robert Kane to the presidency of the college in 1872.

Mr. John Gunn, of Norwich, an English geologist of local reputation, died during the last week in May, in his eighty-ninth year. He was regarded as the chief authority on the formation known as the Cromer Forest Bed, and a most indefatigable and successful collector of its organic contents, and had an extensive knowledge of all the geological formations of East Anglia. He was also interested in antiquarian research. He made a fine collection of fossils illustrating especially the Pliocene mammalian life of England, and presented it to the Norfolk and Norwich Museum, where it occupies the "Gunn Room."

Mr. W. S. Dallas, Assistant Secretary, etc., to the Geological Society of London, and editor of its Quarterly Journal, died May 28th, aged sixty-six years. In early life he became interested in zoölogy, more particularly in the study of insects, relative to which he published many papers in the Transactions of the Entomological Society. In 1851–'52 he published a catalogue of the hemipterous insects in the British Museum, and in 1856 a Natural History of the Animal Kingdom. His later labors were in the direction of scientific literature rather than of original research—of translating, editing, etc.

The death is announced of Dr. F. Soltnedel, Director of the Botanical Station at Samarang, in Java. He was conspicuous in the field of applied botany.

Dr. Karl Jacob Loenig, Professor of Chemistry at the University of Breslau, and author of several eminent works on chemistry, died March 27th, in his eighty-eighth year.

Victor, Ritter von Zepharovich, Professor of Mineralogy at the German University of Prague, died February 24th. He was author of the Mineralogical Dictionary of the Austrian Empire, and of many valuable mineralogical and crystallographical works. He was fifty-nine years of age.

Dr. Karl Emil von Schafhäutl, Professor of Geology, Mining, and Metallurgy in the University of Munich, died in February last, in the eighty-seventh year of his age. He was an eminent physicist and geologist, and a theoretical musician of some note, and was keeper of the geognostic collection of the Bavarian state, and a member of the Academy of Sciences.

The death is announced of M. Soret, an eminent chemist and physicist, of Geneva, Switzerland. He was associated with Regnault in his researches on vapors and determinations of the specific heats of the gases. He afterward published in Switzerland a work on the density of ozone, and investigated the rotatory polarization of quartz. Another of his publications relates to the cause of the blue coloration of the Lake of Geneva.

THOMAS CORWIN MENDENHALL.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

X. THE FALL OF MAN AND ANTHROPOLOGY.

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PART I.

IN the previous chapters we have seen how science, especially within the past few years, has thoroughly changed the intelligent thought of the world in regard to the antiquity of man upon our planet; and how the fabric built upon the chronological indications in our sacred books, first, by the early fathers of the Church, afterward by the mediæval doctors, and finally by the reformers and modern orthodox chronologists, has virtually disappeared before an entirely different view forced upon us, especially by Egyptian studies, Geology, and Archæology.

In this chapter I purpose to present some outlines of the work of Anthropology, especially as assisted by Ethnology, in showing what the evolution of human civilization has been.

Here, too, the change from the old theological view based upon the letter of our sacred books to the modern scientific view based upon evidence absolutely irrefragable, is complete. Here, too, we are at the beginning of a vast change in the basis and modes of thought upon man—a change far more striking than that accomplished by Copernicus and Galileo when they substituted for a universe in which sun and planets revolved about the earth, a universe in which the earth is but the merest grain or atom revolving with other worlds, larger and smaller, about the sun; and all these forming but one among innumerable systems.

Ever since the beginning of man's effective thinking upon the great problems around him, two views have existed regarding the life of the human race upon earth, each utterly opposed to the other. The first of these is the belief that man was created "in the beginning," a perfect being, endowed with the highest moral

and intellectual powers, but that there came a "fall," as the result of which came into the world evil, toil, sorrow, and death.

Nothing could be more natural than such an explanation of the existence of evil, in times when men saw everywhere miracle and nowhere law. It is, under such circumstances, by far the more easy explanation, for it is in accordance with the appearances of things: men adopted it just as naturally as they adopted the theory that the Almighty hangs up the stars as lights in the solid firmament above the earth, or trundles the sun behind a high mountain at night, or wheels the planets around the earth, or flings comets as "signs and wonders" to scare a wicked world, or allows evil spirits to control thunder, lightning, and storm, and to cause diseases of body and mind, or that he opens the "windows of heaven" to let down "the waters that be above the heavens," and thus to give rain upon the earth.

A belief, then, in a primeval period of innocence, physical perfection, and intellectual strength, from which men for some fault fell, is perfectly in accordance with what we should expect.

Among the earliest known records of our race we find this view taking shape in the Chaldean legends of war between the gods, and a fall of man; both of which seemed necessary to explain the existence of evil.

In Greek mythology perhaps the best-known statement was made by Hesiod: to him it was revealed, regarding the men of the most ancient times, that they were, at first, "a golden race," that "as gods they were wont to live, with a life void of care, without labor and trouble; nor was wretched old age at all impending, but ever did they delight themselves out of the reach of all ills, and they died as if overcome by sleep; all blessings were theirs; of its own will the fruitful field would bear them fruit, much and ample, and they gladly used to reap the labors of their hands in quietness along with many good things, being rich in flocks and true to the blessed gods." But there came a "fall" caused by human curiosity. Pandora, the first woman created, received a vase which, by divine command, was to remain closed; but she was tempted to open it, and troubles, sorrow, and sickness in every form escaped into the world, hope alone remaining.

So, too, in Roman mythological poetry, the well-known picture by Ovid is but one among the many exhibitions of this same belief in a primeval golden age—a Saturnian cycle—one of the constantly recurring attempts, so universal and so natural in the early history of man, to account for the existence of evil, care, and toil on earth by explanatory myths and legends.

This view we also find embodied in the sacred tradition of the Jews, and especially in one of the documents which form the impressive poem beginning the books attributed to Moses. As to the

Christian Church, no word of its Blessed Founder indicates that it was committed by Him to this theory, or that He even thought it worthy of his attention: how it was developed it does not lie within the province of this chapter to point out; nor is it worth our while to dwell upon its evolution in the early Church, in the middle ages, at the Reformation, and in various branches of the Protestant Church; suffice it that, though among English-speaking nations, by far the most important influence in its favor has come from Milton's inspiration rather than from that of older sacred books, no doctrine has been more universally accepted, "always, everywhere, and by all," from the earliest fathers of the Church down to the present hour.

On the other hand, appeared at an early period the opposite view—that mankind, instead of having fallen from a high intellectual, moral, and religious condition, has slowly risen from low and brutal beginnings. Among all the statements of this theory one is especially noteworthy; that given by Lucretius in his great poem on The Nature of Things. Despite its errors, it remains among the most remarkable examples of prophetic insight in the history of our race. The inspiration of Lucretius gave him almost miraculous glimpses of truth; his view of the development of civilization from the rudest beginnings to the height of its achievements is a wonderful growth, rooted in observation and thought, branching forth into a multitude of striking facts and fancies; and among these is the statement regarding the sequence of inventions:

> "Man's earliest arms were fingers, teeth, and nails,
> And stones and fragments from the branching woods:
> Then copper next; and last, as latest traced,
> The tyrant, iron."

Thus did the poet prophesy one of the most fruitful achievements of modern science, the discovery of that series of epochs which has been so carefully studied in our century.

Very striking, also, is the statement of Horace, though his idea is evidently derived from Lucretius. He dwells upon man's first condition on earth as low and bestial, and pictures him lurking in caves, progressing from the use of his fists and nails, first to clubs, then to arms which he had learned to forge, and, finally, to the invention of the names of things, to literature, and to laws.*

During the mediæval ages of faith this view was almost entirely obscured, but at the revival of learning in the fifteenth century it reappeared; and in the first part of the seventeenth

* For the passage in Hesiod, as given, see the Works and Days, lines 109–120, in Banks's translation. As to Horace, see the Satires, i, 3, 99. As to the relation of the poetic account of the Fall in Genesis to Chaldean myths, see Smith, Chaldean Account of Genesis, pp. 13, 17. For a very instructive separation of the Jehovistic and Elohistic parts

century we find that among the crimes for which Vanini was sentenced at Toulouse to have his tongue torn out and to be burned alive was his belief that there is a gradation extending upward from the lowest to the highest form of created beings.

In the eighteenth century we find this same idea of an upward progress, especially through the three ages of stone, bronze, and iron, cropping out in scientific form still more definitely from beneath the vast mass of theological reasoning in Germany, France, and England.

The investigations of the last forty years have shown that Lucretius and Horace were inspired prophets: what they saw by the exercise of reason illumined by poetic genius has been now thoroughly based upon facts carefully ascertained and arranged; until Thomsen and Nilsson, the northern archæologists, have brought these prophecies to evident fulfillment, by presenting a scientific classification dividing the age of prehistoric man in various parts of the world between an old stone period, a new stone period, a period of beaten copper, a period of bronze, and a period of iron; and arraying vast masses of facts from all parts of the world, fitting thoroughly into each other, strengthening each other, and showing beyond a doubt that, instead of a *fall*, there has been a *rise* of man from the earliest indications in the Quaternary or even, possibly, in the Tertiary period.*

The first blow at the fully developed doctrine of "the fall" came, as we have seen, from geology. According to that doctrine, as held quite generally from its beginnings among the fathers and doctors of the primitive Church down to its culmination in

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of Genesis, with the account of the "Fall" as given in the former, see Lenormant, La Génèse, Paris, 1883, pp. 166–168. Of the lines of Lucretius—

> "Arma antiqua, manus, ungues, dentesque fuerunt,
> Et lapides, et item sylvarum fragmina rami,
> Posterius ferri vis est, aerisque reperta,
> Sed prior aeris erat, quam ferri cognitus usus"—

the translation given is that of Good. For a more exact prose translation, see Munro's Lucretius, fourth edition, which is much more careful, at least in the proof-reading, than the first edition. As regards Lucretius's prophetic insight into some of the greatest conclusions of modern science, see Munro's Translation and Notes, fourth edition, Book V, Notes II, p. 335. On the relation of several passages in Horace to the ideas of Lucretius, see Munro as above.

* For Vanini, see Topinard, Éléments d'Anthropologie, p. 52. For a brief and careful summary of the agency of Eccard in Germany, Goguet in France, Hoare in England, and others in various parts of Europe, as regards this development of the scientific view during the eighteenth century, see Mortillet, Le Préhistorique, Paris, 1885, chap. i. And for a shorter summary see Lubbock, Prehistoric Man. For the statements by the northern archæologists, see Nilsson, Worsaae, and the other main works cited in this article. For a generous statement regarding the great services of the Danish archæologists in this field, see Quatrefages, Introduction to Cartailhac, Les Ages Préhistoriques de l'Espagne et du Portugal.

the minds of great Protestants like John Wesley, the statement in our sacred books that "death entered the world by sin" was taken as a historic fact, necessitating the conclusion that, before the serpent persuaded Eve to eat of the forbidden fruit, death on our planet was unknown. Naturally, when geology revealed in the strata of a period long before the coming of man on earth, a vast multitude of carnivorous tribes fitted to destroy their fellow-creatures on land and sea, and within the fossilized skeletons of many of these the partially digested remains of animals, this doctrine was too heavy to be carried, and it was quietly dropped.

But about the middle of the nineteenth century the doctrine of the rise of man as opposed to the doctrine of his "fall" received a great accession of strength from a source most unexpected. As we saw in the last chapter, the facts proving the great antiquity of man foreshadowed a new and even more remarkable idea regarding him. We saw, it is true, that the opponents of Boucher de Perthes, while they could not deny his discovery of human implements in the drift, were successful in securing a verdict of "not proven" as regarded his discovery of human bones; but their triumph was short-lived. Many previous discoveries, little thought of up to that time, began to be studied, and others were added which resulted, not merely in confirming the truth regarding the antiquity of man, but in establishing another doctrine which the opponents of science regarded with vastly greater dislike—the doctrine that man has not fallen from an original high estate in which he was created about six thousand years ago; but that, from a period vastly earlier than any warranted by the sacred chronologists, he has been—in spite of lapses and deteriorations here and there—rising.

A brief review of this new growth of truth may be useful. As early as 1835 Prof. Jaeger had brought out from a quantity of Quaternary remains, dug up long before at Cannstadt, near Stuttgart, a portion of a human skull, apparently of very low type. A battle raged about it for a time, but this finally subsided, owing to uncertainties arising from the circumstances of the discovery.

In 1856, in the Neanderthal, near Düsseldorf, among Quaternary remains gathered on the floor of a grotto, another skull was found bearing the same evidence of a low human type. As in the case of the Cannstadt skull, this again was fiercely debated, and finally the questions regarding it were allowed to remain in suspense. But new discoveries were made: at Eguisheim, at Brux, at Spy, and elsewhere human skulls were found of a similarly low type; and while each of the earlier discoveries was open to debate, and either, had no other been discovered, might have been considerd an abnormal specimen, the combination of all these showed conclusively that not only had a race of men existed at that remote

period, but that it was of a type as low as the lowest, perhaps below the lowest, now known.

Research was now redoubled, and, as a result, human skulls and complete skeletons of various types began to be discovered in the ancient deposits of many other parts of the world, and especially in France, Belgium, Germany, the Caucasus, Africa, and North and South America.

But soon began to emerge from all these discoveries a fact of enormous importance: The skulls and bones found at Cro Magnon, Solutré, Furfooz, Grenelle, and elsewhere, were compared, and it was thus made certain that various races had already appeared and lived in various grades of civilization, even in those enormously remote epochs; that even then there were various strata of humanity ranging from races of a very low to those of a very high type; and that upon any theory, certainly upon the theory of the origin of mankind from a single pair, two things were evident: first, that long, slow processes during vast periods of time, must have been required for the differentiation of these races, and for the evolution of man up to the point where the better specimens show him, certainly in the early Quaternary and perhaps in the Tertiary period; and, secondly, that there had been from the first appearance of man, of which we have any traces, an *upward* tendency.*

This second conclusion—the upward tendency of man from low beginnings—was made more and more clear by bringing into relations with these remains of human bodies and of extinct animals the remains of human handiwork. As stated in the last chapter, the river-drift and bone-caves in Great Britain, France, and other parts of the world, revealed a progression, even in the various divisions of the earliest Stone period; for, beginning at the very earliest strata of these remains, on the floors of the caverns, associated mainly with the bones of extinct animals, the cave bear, the hairy elephant, and the like, were the rudest implements;

* For Wesley's statement of the amazing consequences of the entrance of death into the world by sin, see citations from his sermon on The Fall of Man in my chapter on Geology. For Boucher de Perthes, see his Life by Ledieu, especially chapters v and xix; also letters in the appendix; also Les Antiquités Celtiques et Antediluviennes, as cited in previous chapters of this series. For an account of the Neanderthal man and other remains mentioned, see Quatrefages, Human Species, chap. xxvi; also Mortillet, Le Préhistorique, Paris, 1885, pp. 232 *et seq.*, also other writers cited in this chapter. For the other discoveries mentioned, see the same sources. For an engraving of the skull and the restored human face of the Neanderthal man, see Reinach, Antiquités Nationales, etc., vol. i, p. 138. For the vast regions over which that early race spread, see Quatrefages as above, p. 307. See also the same author, Histoire Générale des Races Humaines, in the Bibliothèque Ethnologique, Paris, 1887, p. 4. In the vast mass of literature bearing on this subject, see Quatrefages, Dupont, Reinach, Joly, Mortillet, Tylor, and Lubbock, in works cited through these chapters.

then, in strata above these, sealed in the stalagmite of the cavern floors, lying with the bones of extinct animals, some of them more recent, stone implements were found, still rude, but, as a rule, of an improved type; and, finally, in a still higher stratum, associated with bones of animals like the reindeer and bison, which, though not extinct, have departed to other climates, were rude stone implements, on the whole of a still better workmanship. Such was the foreshadowing, even at that early rude Stone period, of the proofs that the tendency of man has been from his earliest epoch and in all parts of the world, as a rule, upward.

But this rule was to be much further exemplified. About 1850, while the French and English geologists were working more especially among the relics of the drift and cave periods, noted archæologists of the North, Forchammer, Steenstrup, and Worsaae, were devoting themselves to the investigation of certain remains upon the Danish Peninsula. These remains were of two kinds: first, there were vast shell-heaps or accumulations of shells and other refuse cast aside by rude tribes which, at some unknown age in the past, lived on the shores of the Baltic, principally on shell-fish. That these shell-heaps were very ancient was evident; the shells of oysters and the like found in them were far larger than any now found on those coasts; their size, so far from being like that of the corresponding varieties which now exist in the brackish waters of the Baltic, was in every case like that of those varieties which only thrive in the waters of the open salt sea: here was a clear indication that at the time when man formed these shell-heaps those coasts were in far more direct communication with the salt sea than at present, and that sufficient time must have elapsed since that period to have wrought enormous changes in sea and land throughout those regions.

Scattered through these heaps were found indications of a grade of civilization when man still used implements of stone, but implements and weapons, which, though still rude, showed a progress from those of the drift and early cave period; some of them, indeed, being of polished stone.

With these were other evidences that civilization had progressed. With implements rude enough to have survived from early periods, other implements never known in the drift and bone caves began to appear, and though there were few if any bones of other domestic animals, the remains of dogs were found; everything showed that there had been a progress in civilization between the former and this Stone epoch.

The second series of discoveries in Scandinavia was made in the peat-beds; these were generally formed in hollows or bowls varying in depth from ten to thirty feet, and a section of them, like a section of the deposits in the bone caverns, showed a grad-

ual evolution of human culture. The lower strata in these great bowls were found to be made up chiefly of mosses and various plants matted together with the trunks of fallen trees, sometimes of very large diameter; and the botanical examination of the lowest layer of these trees and plants in the various bowls revealed a most important fact: for this layer, the first in point of time, was always of the Scotch fir—which now grows nowhere in the Danish islands, and can not be made to grow anywhere in them—and of plants which are now extinct in these regions, but have retreated within the Arctic Circle. Coming up from the bottom of these great bowls there was found above the first layer a second, in which were matted together masses of oak-trees of different varieties; these, too, were relics of a bygone epoch, since the oak has almost entirely disappeared from Denmark. Above these came a third stratum made up of fallen beech-trees, and the beech is now the most common tree of the Danish Peninsula.

And now came a second fact of the utmost importance as connected with the first: scattered, as a rule, through the lower of these deposits, that of the extinct fir-trees and plants, were found implements and weapons of smooth stone; in the layer of oak-trees were found implements of bronze; and among the layer of beeches were found implements and weapons of iron.

The general result of these investigations in these two sources, the shell mounds and the peat deposits, was the same: the first civilization evidenced in them was marked by the use of stone implements more or less smooth, showing a progress from the earlier rude Stone period made known by the bone caves; then came a later progress to a higher civilization, marked by the use of bronze implements; and, finally, a still higher development when iron began to be used.

The labors of the Danish archæologists have resulted in the formation of a great museum at Copenhagen, and on the specimens they have found, coupled with those of the drift and bone caves, is based the classification between the main periods or divisions in the evolution of the human race above referred to.

It was not merely in Scandinavian lands that these results were reached; substantially the same discoveries were made in Ireland and France, in Sardinia and Portugal, in Japan and in Brazil, in Cuba and in this country; in fact, as a rule, in nearly every part of the world which was thoroughly examined.*

* For the general subject, see Mortillet, Le Préhistorique, p. 498, *et passim*. For examples of the rude stone implements, improving as we go from earlier to later layers in the bone caves, see Boyd Dawkins, Early Man in Britain, chap. vii, p. 186; also Quatrefages, Human Species, New York, 1879, pp. 305 *et seq*. An interesting gleam of light is thrown on the subject in De Baye, Grottes Préhistoriques de la Marne, pp. 31 *et seq*.; also Evans, as cited in the previous chapter. For the more recent investigations in the Danish shell-heaps, see

But from another quarter came a yet more striking indication of this same evolution. As far back as the year 1829 there were discovered, in the Lake of Zurich, piles and other antiquities indicating a former existence of human dwellings, standing in the water at some distance from the shore; but the usual mixture of thoughtlessness and dread of new ideas seems to have prevailed, and nothing was done until about 1853, when new discoveries of the same kind were followed up vigorously, and such men as Rütimeyer, Keller, and Troyon showed not only in the Lake of Zurich, but in many other lakes in Switzerland, remains of former habitations, and, in the midst of these, great numbers of relics, exhibiting the grade of civilization which those lake-dwellers had attained.

Here, too, were accumulated proofs of the upward tendency of the human race. Implements of polished stone, bone, leather, pottery of various grades, woven cloth, bones of several kinds of domestic animals, various sorts of grain, bread which had been preserved by charring, and a multitude of evidences of progress never found among the earlier, ruder relics of civilization, showed yet more strongly that man had arrived here at yet a higher stage than his predecessor of the drift, cave, and shell-heap periods, and had gone on from better to better.

Very striking evidences of this upward tendency were found in each class of implements: as by comparing the chipped flint implements of the lower and earlier strata in the cave period with those of the latter and upper strata we saw progress, so, in each of the periods of polished stone, bronze, and iron, we see a steady progress from rude to perfected implements; especially is this true in the remains of the various lake-dwellings, for among these can be traced out constant improvements in means of subsistence and in ways of living.

Incidentally, too, a fact—at first sight of small account, but on reflection exceedingly important—was revealed. The earlier bronze implements were frequently found to imitate in various minor respects implements of stone; in other words, forms were at first given to bronze implements natural in working stone, but not natural in working bronze. This showed the *direction* of the development—that it was upward from stone to bronze, not down-

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Boyd Dawkins, Early Man in Britain, pp. 303, 304. For these evidences of advanced civilization in the shell-heaps, see Mortillet, p. 498. He, like Nilsson, says, that only the bones of the dog were found; but compare Dawkins, p. 305. For the very full list of these discoveries, with their bearing on each other, see Mortillet, p. 499. As to those in Scandinavian countries, see Nilsson, The Primitive Inhabitants of Scandinavia, third edition, with Introduction by Lubbock, London, 1868; also the Pre-History of the North, by Worsaae, English translation, London, 1886. For shell-mounds and their contents in the Spanish Peninsula, see Cartailhac's greater work already cited. For summary of such discoveries throughout the world, see Mortillet, Le Préhistorique, pp. 497 *et seq.*

ward from bronze to stone; that it was progress rather than decline.

These investigations were supplemented by similar researches elsewhere. In many other parts of the world it was found that lake-dwellers had existed in different grades of civilization, but all within a certain range, intermediate between the cave-dwellers and the historic period. To explain this epoch of the lake-dwellers history came in with the account given by Herodotus of the lake-dwellings on Lake Prasias, which gave protection from the armies of Persia. Still more important, Comparative Ethnography showed that to-day, in various parts of the world, especially in New Guinea and West Africa, races of men are living in lake-dwellings built upon piles, and with a range of implements and weapons strikingly like many of those discovered in these ancient lake deposits of Switzerland.

In Great Britain, France, Germany, Italy, Ireland, Scotland, and other countries, remains of a different sort were also found, throwing light on this progress. The cromlechs, cranogs, mounds, and the like, though some of them indicate the work of weaker tribes pressed upon by stronger, show, as a rule, the same upward tendency.

At a very early period in the history of these discoveries, various attempts were made, in the supposed interest of Scripture, to break the force of such evidences of the progress and development of the human race from lower to higher. Out of all the earlier efforts two may be taken as fairly typical, for they exhibit the opposition as developed under two different schools of theology, each working in its own way. The first of these shows great ingenuity and learning, and is presented by Mr. Southall, in his book, published in 1875, entitled The Recent Origin of the World. In this he grapples first of all with the difficulties presented by the early date of Egyptian civilization, and the keynote of his argument is the statement made by an eminent Egyptologist, at a period before modern archæological discoveries were well understood, that "Egypt laughs the idea of a rude stone age, a polished stone age, a bronze age, an iron age, to scorn."

Mr. Southall's method was substantially that of the late excellent Mr. Gosse in geology. Mr. Gosse, as the readers of these chapters may remember, felt obliged, in the supposed interest of Genesis, to insist that the only safety was in believing that, six thousand years ago, the Almighty, for some inscrutable purpose, in a moment, set Niagara pouring very near the spot where it is pouring now; laid the various strata, and sprinkled the fossils through them like plums through a pudding; scratched the glacial grooves upon the rocks, and did the vast multitude of things, little and great, in all parts of the world, required to delude geologists

of modern times into the conviction that all these things were the result of a steady progress through long epochs. On a similar plan, Mr. Southall proposed, at the very beginning of his book, as a final solution of the problem, the declaration that Egypt, with its high civilization in the time of Mena, with its races, classes, institutions, arrangements, language, monuments—all indicating an evolution through a vast previous history—was a sudden creation which came fully made from the hands of the Creator. To use his own words, "The Egyptians had no stone age, and were born civilized."

There is an old story that once on a time a certain jovial King of France, making a progress through his kingdom, was received at the gates of a provincial town by the mayor's deputy, who began his speech on this wise: "May it please your Majesty, there are just thirteen reasons why his honor the mayor can not be present to welcome you this morning. The first of these reasons is that he is dead." On this the king graciously declared that this first reason was sufficient, and that he would not trouble the mayor's deputy for the twelve others.

So with Mr. Southall's argument: one simple result of scientific research out of many is all that it is needful to state, and this is, that in these later years we have a new and convincing evidence of the existence of prehistoric man in Egypt in his earliest, rudest beginnings—the very same evidence which we find in all other parts of the world which have been carefully examined. This evidence consists of stone implements which have been found in Egypt in such forms, at such points, and in such positions that when studied in connection with those found in all other parts of the world, from New Jersey to California, from France to India, and from England to the Andaman Islands, they force upon us the conviction that civilization in Egypt, as in all other parts of the world, was developed by the same slow process of evolution from the rudest beginnings.

It is true that men learned in Egyptology had discouraged the idea of an earlier stone age in Egypt, and that among these were Lepsius and Brugsch; but these men were not trained in prehistoric archæology; their devotion to the study of the monuments of Egyptian civilization had evidently drawn them away from sympathy, and indeed from acquaintance with the work of men like Boucher de Perthes, Lartet, Nilsson, Troyon, and Dawkins. But a new era was beginning: in 1867 Worsaae called attention to the prehistoric implements found on the borders of Egypt; two years later Arcelin discussed such stone implements found beneath the soil of Sakkara and Ghizeh, the very focus of the earliest Egyptian civilization; in the same year Hamy and Lenormant found such implements washed out from

the depths higher up the Nile at Thebes, near the tombs of the kings; and in the following year they exhibited more flint implements found at various other places. Coupled with these discoveries was the fact that Horner and Linant found a copper knife at twenty-four feet and pottery at sixty feet below the surface. In 1872 Dr. Reil, director of the baths at Helouan, near Cairo, discovered implements of chipped flint; and in 1877 Dr. Jukes Brown made similar discoveries in that region. In 1878 Oscar Fraas, summing up the question, showed that the stone implements were mainly such as are found in the prehistoric deposits of other countries, and that Zittel, having found them in the Libyan Desert, far from the oases, there was reason to suppose that these implements were used before the region became a desert and before Egypt was civilized. Two years later Dr. Mook, of Würzburg, published a work giving the results of his investigations with careful drawings of the rude stone implements discovered by him in the upper Nile Valley, and it was evident that, while some of these implements differed slightly from those before known, the great mass of them were of the character so common in the prehistoric deposits of other parts of the world.

A yet more important contribution to this mass of facts was made by Prof. Henry Haynes, of Boston, who in the winter of 1877 and 1878 began a very thorough investigation of the subject, and discovered, a few miles east of Cairo, many flint implements. The significance of Haynes's discoveries was twofold: First, there were, among these, stone axes like those found in the French drift-beds of St. Acheul, showing that the men who made these in Egypt were passing through the same phase of savagery as that of Quaternary France; secondly, he found a workshop for making these implements, proving that these flint implements were not brought into Egypt by invaders, but made to meet the necessities of the country. From this first field Prof. Haynes went to Helouan, north of Cairo, and there found, as Dr. Reil had done, various worked flints, some of them like those discovered by M. Rivière in the caves of southern France; thence he went up the Nile to Luxor, the site of ancient Thebes, began a thorough search in the Tertiary limestone hills, and found multitudes of chipped stone implements, some of them, indeed, of original forms, but most of forms common in other parts of the world under similar circumstances, some of the chipped stone axes corresponding closely to those found in the drift-beds of northern France.

Nothing in its way can be more perfect than the modest monograph in which Prof. Haynes records these researches, and the photographs of these chipped flint implements show conclusively that, long ages before the earliest period of Egyptian civilization of which the monuments of the first dynasties give us any trace,

mankind in the Nile Valley was going through the same slow progress from the period when, standing just above the brutes, he defended himself with implements of rudely chipped stone.

But in 1881 came discoveries which settled the question entirely. In that year General Pitt-Rivers, a Fellow of the Royal Society and President of the Anthropological Institute, and J. F. Campbell, Fellow of the Royal Geographical Society of England, found implements not only in alluvial deposits, associated with the bones of the zebra, hyena, and other animals which have since retreated farther south, but, at Djebel Assas, near Thebes, they found implements of chipped flint in the hard, stratified gravel, from six and a half to ten feet below the surface; relics evidently, as Mr. Campbell says, "beyond calculation older than the oldest Egyptian temples and tombs." They certainly proved that Egyptian civilization had not issued in its completeness, and all at once, from the hand of the Creator in the time of Menes. Thus was ended the contention of Mr. Southall.

Still another attack upon the new scientific conclusions came from France, when in 1883 the Abbé Hamard, Priest of the Oratory, published his Age of Stone and Primitive Man. He had been especially stirred up by the arrangement of prehistoric implements by periods at the Paris Exposition of 1878; he bitterly complains of all these as having an anti-Christian tendency, and rails at science as "the idol of the day." He attacks Mortillet, one of the leaders in French archæology, with a great display of contempt; speaks of the "venom" in books on prehistoric man generally; complains that the Church is too mild and gentle with such monstrous doctrines; bewails the concessions made to science by some eminent preachers, and foretells his own martydom at the hands of men of science.

Efforts like these accomplished little, and a more legitimate attempt was made to resist the conclusions of archæology in Egypt by showing that knives of stone were used in obedience to a sacred ritual in Egypt for embalming and in Judea for circumcision, and that these flint knives might have had this later origin. But the argument against this view was triple: First, as we have seen, not only stone knives, but axes and other implements of stone similar to those of a prehistoric period in western Europe were discovered; secondly, these implements were discovered in the hard gravel drift of a period evidently far earlier than that of Menes; and, thirdly, the use of stone implements in Egyptian and Jewish sacred functions, so far from weakening the force of the arguments for the long and slow development of Egyptian civilization from the men who used rude flint implements to the men who built and adorned the great temples of the early dynasties, is really an argument in favor of that long evolution. A study of

comparative ethnology has made it clear that the sacred stone knives and implements of the Egyptian and Jewish priestly ritual were natural survivals of that previous period. For sacrificial or ritual purposes, the knife of stone was considered more sacred than the knife of bronze or iron, simply because it was ancient; just as to-day in India, Brahman priests kindle the sacred fire, not with matches or flint and steel, but by a process found in the earliest, lowest stages of human culture—by violently boring a pointed stick into another piece of wood until a spark comes; and just as to-day, in Europe and America, the architecture of the middle ages survives as a special religious form in the erection of our most recent churches, and to such an extent that thousands on thousands of us feel that we can not worship fitly unless in the midst of windows, decorations, vessels, implements, vestments, and ornaments, no longer used elsewhere, but which have survived in sundry branches of the Christian Church, and derived a special sanctity from the fact that they are of ancient origin.

Taking, then, the whole mass of testimony together, even though a plausible or very strong argument against single evidences may be made here and there, the force of its combined mass remains, and leaves both the vast antiquity of man and the evolution of civilization from its lowest to its highest forms, as proved by the prehistoric remains of Egypt and so many other countries in all parts of the world, beyond a reasonable doubt.*

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* For Mr. Southall's views, see his Recent Origin of Man, p. 20, and elsewhere. For Mr. Gosse's views, see his Omphalos as cited in the chapter on Geology in this series. For a summary of the work of Arcelin, Hamy, Lenormant, Richard, Lubbock, Mook, and Haynes, see Mortillet, Le Préhistorique, *passim*. As to Zittel's discovery, see Oscar Fraas's Aus dem Orient, Stuttgart, 1878. As to the striking similarities of the stone implements found in Egypt with those found in the drift and bone caves, see Mook's Monograph, Würzburg, 1880, cited in the last chapter of this series, especially Plates IX, XI, XII. For even more striking reproductions of photographs showing this remarkable similarity between Egyptian and European chipped stone remains, see H. W. Haynes, Palæolithic Implements in Upper Egypt, Boston, 1881. See also Evans, Ancient Stone Implements, chap. i, pp. 8, 9, 44, 102, 316, 329. As to stone implements used by priests of Jehovah, priests of Baal, priests of Moloch, and priests of Odin, as religious survivals, see Cartailhac, as above, 6 and 7; also Lartet in De Luynes, Expedition to the Dead Sea; also Nilsson, Primitive Inhabitants of Scandinavia, pp. 96, 97. For the discoveries by Pitt-Rivers, see the Journal of the Anthropological Institute of Great Britain and Ireland for 1881, vol. xi, pp. 382 *et seq.*; and for Campbell's decision regarding them, see ibid., pp. 396, 397. For facts summed up in the words, "It is most probable that Egypt at a remote period passed like many other countries through its stone period," see Hilton Price, F. S. A., F. G. S., paper in the Journal of the Archæological Institute of Great Britain and Ireland for 1884, p. 56. Specimens of palæolithic implements from Egypt—knives, arrow-heads, spear-heads, flakes, and the like, both of peculiar and ordinary forms—may be seen in various museums, but especially in that of Prof. Haynes, of Boston. Some interesting light is also thrown into the subject by the specimens obtained by General Wilson and deposited in the Smithsonian Institution at Washington. For the Abbé Hamard's attack, see his L'Âge de la Pierre et l'Homme Primitif, Paris, 1883—especially his preface.

COMMON SENSE APPLIED TO THE TARIFF QUESTION.

By EDWARD ATKINSON.

II.

"WE are at the parting of the ways." Any one who takes the ground that the main object which should be kept in view in placing taxes upon foreign imports may rightly be an attempt to establish any and every branch of industry, great and small, without regarding the use to which imports are to be put, and without any consideration of the temporary obstruction to other branches of industry which must follow any interference with the natural course of trade, may take his own way; he will have no further interest in this essay. Such men may separate themselves under the guidance of their chosen leaders, for such influence upon the question of taxation as they may be capable of exerting. Their position is a very plain one, and it has been rightly named by its chief exponent, the chairman of the Committee of Ways and Means, the method of "*protection with incidental revenue.*" May it not be held that this method is inconsistent with the public welfare and that it is contrary to the very principle of law which has been established by the Supreme Court of the United States in the case of the Loan Association *vs.* Topeka?

In this case, Justice Miller, on behalf of the court, stated this fundamental principle of law as follows: "To lay with one hand the power of the Government on the property of the citizen, and with the other bestow it on favored individuals to aid private undertakings, and to build up private enterprises, is none the less robbery because it is done under the forms of law and is called taxation. This is not legislation; it is a decree under legislative forms. . . . Beyond a cavil there can be no lawful tax which is not laid for a public purpose."

I think it must be clear to every unprejudiced mind that the theory of Mr. McKinley, of "*protection with incidental revenue,*" is in fact forbidden by this dictum of the Supreme Court. It can only be justified by a legal subterfuge, to wit, that a public purpose or necessity exists which justifies doing away with the revenue duty on sugar, thereby depriving the Government of all revenue from that source, and continuing to tax the people in order to pay a bounty to the sugar-planters. The bounty to sugar-planters must be justified, if justified at all, upon the ground that public necessity requires the production of sugar within the limits of our own country, although sugar can be procured at less cost in exchange for wheat, cotton, and oil. If

not so justified, the tax from which the bounty is to be "bestowed upon private individuals to aid private enterprises becomes none the less robbery because it is done under the forms of law, and is called taxation."

This proposition brings the effect of this theory of protection directly into view; one may well ask why the same method should not be adopted to promote other branches of industry. It is admittedly more important that this country should make its own iron than that it should make its own sugar, and the heavy duties on iron and steel have been justified upon the ground that it is for the public interest to make this country independent of all others in the production of iron. It is now independent, whether we will or no; we are consuming thirty-five to forty per cent of the iron of the world and no other country could possibly supply us. On the plea that this branch of industry should be sustained, the consumers of iron and steel in this country have paid a sum in excess of the price paid by the consumers who have been supplied by Great Britain and Germany, ranging from $50,000,000 to $80,000,000 a year for the last ten years. The excess of price has not been paid over to the workmen by the owners of the mines and works, it has been bestowed upon private individuals to aid private enterprises. One has only to examine the average wages of the workmen in the iron mines and works of this country to be convinced that they are much less than the wages of those who are engaged in the conversion of crude iron and steel into machinery, tools, beams, bars, and other forms for use. If it were proposed to remit all duties upon iron and steel, and to pay a bounty to the producers of these crude metals, equal to the excess of price which we have paid for the last ten years, would not that bring the case directly under the law as laid down by Justice Miller? If under such circumstances it would come directly under the law, why does not the case come indirectly under the law, provided a case could be made up to test the question in court? It might be difficult, as a matter of practice, to bring the case into court, but I am inclined to think that if this policy of protection with incidental revenue were to be forced into effect by the votes of a temporary majority of the Congress of the United States, a way might be found to bring this subject before the Supreme Court and to abate this evil by a decision of the court. That is the way by which many of the abuses of the taxing power have been prevented, but the remedy can be more easily applied through legislation. The present tax upon the import of tin plates is purely a revenue measure, because no one makes such plates in this country. The object of raising this tax to twice the rate now levied is that "a bounty may be bestowed upon private individuals in order to aid them in the private enterprise" of

making tin plates. The income of the tax has been asked for this purpose—it has been granted by the majority of the Committee of Ways and Means for this purpose—it is consistent with the so-called principle of protection with incidental revenue, and not a man who has voted for this measure in the House of Representatives can deny that, under the ruling of the Supreme Court, this method "is not legislation; it is a decree under legislative forms, and is none the less robbery because it is called taxation."

On the other hand, almost all the advocates of the theory of protection according to the principles of its founders—viz., temporary support during the period of the infancy of any art—may now be ready to join with the reasonable advocates of freer trade in coming to an agreement upon a measure which would be consistent with existing conditions, and also consistent with common sense. All admit, as Sir Robert Peel did, that we can not apply the absolute theory of free trade at the present time. But we can lay aside our prejudices; we can treat the whole subject in a judicial way; we can adopt a measure of tariff reform which shall lead in due season to such free trade as may be consistent with the necessity of deriving a revenue from duties upon imports, the subjects of taxation being selected with a view to the least burden upon consumers.

We may now take up the right method of bringing an agreement on method into practice and thereby giving the necessary direction to our legislators, who are all seeking for guidance among their constituents. How can we expect legislators to make good laws if their constituents do not themselves know what kind of laws they want?

When this subject is thus approached in a judicial way, there are two lines of preliminary research and two sets of facts of which full cognizance must be taken:

The home market of this country rests for its development, its stability and its profit, upon the prosperity of the great mass of the consumers of this country who are working people busily occupied for gain in all the arts of life; of whom a vast majority are "working people" even in the narrow sense in which that term is commonly used. The census of occupations of those who are engaged in gainful pursuits is doubtless about as accurate as the enumeration of the population itself. Those who are thus occupied for gain and who do all the work of production and distribution, and who enjoy greater or less abundance in their consumption according to their larger or lesser share of the joint annual product, number one in three of the whole population, disregarding fractions. They are listed under different heads, viz.—four general classes, and a great many sub-classes under each of the general heads. The proportions under the four general classes

have not varied much for several decades. According to the census of 1880, the total number of all who were occupied for gain was 17,400,000 out of 50,000,000. (I will omit fractions in dealing with these figures.) A little over twenty-three per cent, numbering about 4,000,000, were occupied in professional and personal service. There can, of course, be no direct foreign competition with this class through the import of products. Ten and four tenths per cent, numbering a little over 1,800,000, were occupied in trade and transportation; there can be no import of foreign products to compete with this class; it matters not to them what they move or what they may deal in. Forty-four per cent, numbering a little over 7,600,000, were occupied in agriculture as farmers and farm laborers, fruit cultivators, shepherds, and the like; and, lastly, twenty-two per cent, numbering a little over 3,800,000, were occupied in the manufacturing and mechanic arts and in mining. All who could or can be subjected to any change in the direction of their industry by alterations in the tariff policy of this country are substantially included in the two latter classes—i. e., in agriculture and manufactures.

According to the valuation of the products of agriculture, which was carefully revised by the Department of Agriculture after the census had been taken, the total value of the product of this great body of farmers and farm laborers, numbering 7,600,000, was a little under $4,000,000,000; that part of the product which consisted of sugar, tobacco, hemp, flax, wool, fruits, and the like, or of any other articles which could be in any part imported from abroad, came to less than $200,000,000—or less than five per cent of the total. It follows that not exceeding 350,000 to 400,000 of all who were occupied in agriculture could be subjected to any adverse influence by changes in the tariff, even if a larger proportion of these necessary articles were imported free of duty than had been imported while subject to duty; this estimate by persons being made in ratio to the relative value of different products.

In this consideration we of course leave out the Dominion of Canada. Owing to the difference in climate and to our advantage of position, there is a considerable exchange of products of agriculture between us and our neighbors in Canada; the amounts about balance. On the whole, we supply Canada with a rather larger part of the products of agriculture than they can supply to us. But the total traffic is relatively a very small part of our commerce, and may be wholly set aside, especially since the advocates both of protection and of freer trade are coming together in sustaining reciprocity among the nations on the American continents, especially with Canada.

On the other hand, in 1880, seventeen per cent of the value of

the product of agriculture found its home market only by sale for export to foreign countries; since then the proportion of exports has diminished; exports now range from ten to fifteen per cent in value of the total product of agriculture, varying with the relative supply and demand. It therefore follows that there is a vastly greater proportion of farmers and farm laborers whose home market depends upon the export trade than there are of those who might possibly be harmed even if, through imports of foreign articles of like kind, the demand for their own product were reduced.

When we take up the fourth class, manufacturing and mechanic arts and mining, one's judgment may vary as to the proportion whose home market depends upon export and the proportion whose product could be in part imported from a foreign country. In a rough and ready way it may be said that about one half the total number under this head of 3,800,000 were mechanics engaged in building trades or in other arts which can not be conducted on the factory principle, and which can not be interfered with or affected to their detriment by any import from any foreign country, but may be greatly benefited by the removal of taxes from the materials on which they work.

It is not worth while at this time to enter into the details of the classification of the other half of this number. Let it be admitted that there are about 1,900,000 to 2,000,000 people more or less, each of whom supports two others who are occupied distinctly in the manufacturing and mechanic arts, a part of whose work may be promoted by a tariff, and a part of whose work might perhaps be adversely affected by injudicious or revolutionary changes in the tariff policy of the country. The main point of this analysis is to call attention to the fact that at least eighty per cent, and probably more, of all who are occupied for gain in this country, have no direct interest in the tariff question except *as consumers;* while the remainder, about evenly divided between producers and consumers, may be affected more or less by changes in the tariff system to their benefit, or to their injury by injudicious or revolutionary changes.

There are probably twelve to fifteen hundred thousand persons occupied mainly in agriculture, but partly in the mining, mechanic, and manufacturing arts, whose home market depends absolutely on sales for export, and about ten to twelve hundred thousand occupied mainly in manufacturing and mining but in lesser proportion in agriculture, whose product would be in part imported if all duties on their products were abated. The reduction or abatement of duties on imports would necessarily promote exports, but how much imports would be increased or diminished can not be determined until the effect of the removal of duties on

crude or partly manufactured materials shall have given our domestic manufacturers an even chance to compete with others.

If it be admitted that the number of persons who are occupied in branches of agriculture, in manufactures, and in mining, whose home market depends wholly upon sales for export to other countries, exceeds the number of those who are occupied in any branch of domestic production of which a part might be imported under other conditions, then it follows of necessity that the only effect of duties upon imports has been or is to give a different direction to domestic industry from that which it would otherwise have taken. By such a course we do not add anything to or take away anything from the work that is to be done, but we do or may diminish the value of the domestic product from which all wages and profits are alike derived, by restricting its market, thus diminishing both general wages and profits in the attempt to increase them in specific directions. If the import of foreign goods, either crude or manufactured, is obstructed, then it follows of necessity that the export of the products of the farm and of the mine is to that extent obstructed, because we buy our foreign goods in exchange for food that we can not consume, for cotton that we can not spin, and for oil that we can not burn. "But," some one says, "if these foreign goods were manufactured at home, there would then be the same market for the product of the farm, the mine, and the forest, within the limit of our country, that now exists abroad." That view of the matter opens a very complex question. One can neither admit nor deny that position, because we have no experience to guide us. If, however, we did make the finished goods which we import into this country, the work in the factories in which they would be made would give employment to a very much less number of laborers than are engaged in the product of wheat and cotton which we now exchange for them. The home market which would be established in this artificial way would not take up anything like the quantity of products of the farm, the mine, and the forest that is now exported.

To show the absurdity of this conception, I can not do better than to quote from Mr. Butterworth's late speech. Having laid down his base-line principle with reference to the revision of the tariff, viz., that of reduction, he says: "Otherwise we should have five gentlemen, honorable and learned gentlemen, arbitrarily shuffling and disarranging, according to their own partially enlightened judgment, the more than fifty thousand industries of sixty millions of people, scattered over a vast continent, affecting directly and indirectly every home in the land, and having to do with all the nations of the earth."

Is it not a simple absurdity to expect the men whom we elect

to Congress, whose capacity or whose want of capacity we all know; many of whom we would never choose to manage a single large corporation, bank, or other commercial enterprise—to be able to choose and direct the occupations of this people? Are such men as our members of Congress to be empowered to say to us, This branch of work you shall do, and that branch of work you shall not do? What an absurdity! As if the people were not more competent than any Congress that ever existed, and more capable of managing their own affairs than the average member.

Again, what could be more absurd than the bugbear which is held up to us, of a community which would be exclusively devoted to agriculture, as the penalty for doing away with protection to domestic industry? Such a community never existed upon this continent except in the slave States. There, owing to slavery, we had a community almost wholly devoted to agriculture, and this was due to the coercion of law and the attempt to direct and control the labor of a great community by statute.

The first pamphlet ever printed by the writer, on Cheap Cotton by Free Labor, was devoted to an economic review of the slave system of labor. In that and in other articles I treated the system purely from the economic standpoint; I ventured to predict the changes which would come whenever the attempt to direct the labor of the community by the force of slavery should be removed. When the economic history of the present generation shall be written, it will give a picture of the most wonderful industrial revolution that has ever been witnessed, and it will do away forever with the conception that infant industries require even temporary support from the Government.

Witness the conditions. In 1865 the people of the Southern States were subjected not only to a revolution of institutions but of ideas. A considerable part of the most effective brain-power of the South was disfranchised as a penalty for having taken part in the rebellion, while the franchise was given to the most ignorant portion of the community. I fully justify the enfranchisement —the protection of the ballot was necessary to the black citizens of the United States—but I have never justified the disfranchisement. The result was as bad as it could be. We all know the history of what had been miscalled "carpet-bag" governments. They were not "carpet-bag" governments in any single State, so far as I can find out. The Northern men who took part in the readmission of the Southern States brought to their aid the best constitutional lawyers, and the organic laws of these States were most admirably framed and carried through by them. It was in specific legislation under these organic laws that the abuses happened; and, so far as I can learn, there was not one single instance or not one single law called into existence under these

conditions, in which the majority of white men were not Southern born and Southern bred in each so-called "carpet-bag Legislature." If, then, the ignorant blacks were led to pervert the trust that was imposed upon them, they were not led thereto by the Northern "carpet-baggers."

The very necessities of society made it necessary that this perversion of the powers of government should be stopped. It was done; and the old colored man at the Capitol in South Carolina explained the case in a single phrase when I asked him why the Republican Governor had been thrown out and Wade Hampton elected the year before; his answer was, "Yer can't put ig'nance top o' 'telligence and make it stay dar." It might be wise for those who are pressing the "Force bill" in the present Congress to take counsel from this old colored man. No force bill can "put ig'nance on top o' 'telligence and make it stay dar," but the enactment of such a measure will make it very plain that intelligence must displace ignorance of the present conditions of the South in many of the seats in the present House and Senate.

Under these adverse conditions—with that element of property which had been the main-stay of its citizens totally destroyed, its railway system torn up, its fields devastated, its fences burned, and many of its most important mills and works utterly destroyed; without capital, without inherited skill or aptitude—the South entered upon new fields of industry, exposed to the absolutely free and unrestricted competition of the Northern farmers, the Northern miners, the Northern manufacturers and the Northern artisans and mechanics in every branch of work.

No one can yet measure the progress which has been made in all the arts and industries which are necessary to civilized life in that great Southland. I have lately been on a hasty trip as far as New Orleans; I have witnessed the progress of white and black alike; progress upon the farm, in the field, in the great factory, in the workshop; progress in better conditions of life, in higher wages and in lower cost, in every town and city and wherever the railway has penetrated. It is a complete proof that diversity of employment establishes itself in spite of legislation and in spite of every bad form of taxation.

If you will glance over the analysis of the occupations of the people of the several States in the census of 1880, limiting your observation to those which had not been subject to the indignity of slavery, you will find that in a very short time after a State or Territory is open to settlement a certain balance of occupations establishes itself. Where the land is poor, as in New England, the larger number will be occupied in the manufacturing and mechanic arts; where the land is good, and the connection with the markets established, there may be for a time an excess in

agriculture as compared with other occupations; but after the normal conditions have become established by long settlement, as in Ohio, for instance—a State midway between the great prairies of the West and the factories of the East—we find that, although there is almost nothing produced in Ohio which could be imported from any foreign country, except a little wool and a little pig-iron —the two together constituting a small proportion of the product of the State and giving employment in 1880 to only thirty-two thousand out of one million persons then occupied for gain, rating persons in ratio to the relative value of products—the balance of occupations is about the same as that which has established itself on the average throughout the country. That average is forty to forty-five per cent in agriculture; ten to eleven per cent in trade and transportation; twenty to twenty-four per cent in professional and personal service; twenty to twenty-four per cent in manufacturing and mechanic arts and in mining.

The error which Mr. Gladstone has made in his article in the North American Review, to which Mr. Blaine replied, is of this nature. If I read his article correctly from his standpoint, I think he holds to the mistaken idea that the conditions of this country are more especially adapted to agriculture than to the manufacturing arts. A greater mistake could not be made. We possess greater advantages in our natural conditions and resources for the establishment of the mining industry, the mechanic arts and manufacturing, than we do in agriculture; and it is only due to our own blunders that we do not take the paramount position in the world in all these arts.

On the other hand, the reply of Mr. Blaine is full of yet more gross errors; not errors of opinion, but errors in the statement of facts. A more mistaken or erroneous statement of the course of economic history not only in Great Britain but also in this country, could hardly have been compiled than is found in Mr. Blaine's reply to Mr. Gladstone. A complete review of these two articles remains to be written.

So much for the analysis by persons. Now, if we adopt the theory so well laid down by Sir Robert Peel, after he had become convinced of the necessity of tariff reform, that if our condition had not been changed by our long persistence in a high tariff policy, we might choose the subjects from which to derive our revenue so as to interfere in the least degree either with commerce, agriculture, or manufactures—then the collection of our necessary revenue either from customs or from excise, or both, would become a very simple matter.

Let us for a moment take up this subject as a matter of theory and not of condition. Let us investigate our resources, and lay out an ideal method for collecting the national revenue wholly

from articles of voluntary rather than of necessary use, exempting everything that enters into the process of domestic industry, and taxing only those articles of which consumers may even be deprived of some part on account of the cost, and yet not be in any degree harmed or prevented from doing the most effective work of which they are capable; our object being to leave them free, so as to be able to obtain the largest annual product either by the application of the labor of the people of the country to its own resources, or indirectly by devoting their labor and capital to exchanging their own products for articles of necessity which may be of foreign origin, thus securing every article of necessity at the lowest cost, whether of foreign or of domestic origin. We could then raise all the necessary revenue from spirits, wines, beer, sugar, tea, coffee, silks, the finer textile fabrics of wool and cotton, laces, embroideries, furs, and fancy goods.

In order to apply this theory to our present condition, we may take as our basis the estimates of the Secretary of the Treasury for the ensuing fiscal year; but in so doing we must bear in mind that there has scarcely been a single estimate of prospective revenue submitted by any Secretary for the last twenty-five years which has not been *exceeded* in result; we must also bear in mind, in considering estimates of expenditure, that the recommendations of the Secretary of the Treasury have been more apt to be cut down by Congress than to be increased. At the present time, however, when our legislators are so anxious to dispose of a surplus in order that they may not be called upon to reduce taxation, we may find an exception to this latter rule; but for the purposes of study the ordinary conditions may be applied to the present case.

I might have attempted to lay down the basis for an act for the collection of our national revenue consistently with theory; of course, our condition will not permit the immediate application of this theory in its full force on account of our present conditions. A beginning, however, may be made; and, as the effects of the changes upon the progress of the country are developed, the work can proceed more and more rapidly.

No one can yet venture to forecast the prosperity of this country which would ensue the moment all crude and partly manufactured materials which are necessary in the main processes of our domestic industry were made free from duties, and were therefore supplied to our domestic manufacturers on even terms with our competitors in other countries. As one can not forecast the beneficial effect of the removal of these taxes, so no one can measure the injury which has been inflicted in consequence of the higher price of iron, steel, copper, lead, and other metals, of wool, chemicals and dye-stuffs, through this long term of high-tariff obstruction.

The true change may now be readily brought about, because the masters of the art of converting ore into iron have become aware that, owing to the scarcity of the fine ores suitable for the Bessemer metal, and of coal suitable for coking in Great Britain, the paramount control of the metal industry is passing to this country; it needs only the maintenance of the prices on the other side without a reduction of our own, to put us in a position of advantage for converting the crude metals into the higher forms in which ten or twenty men may be called for as compared to one in the production of pig-iron, copper, lead, and zinc. The prosperity which would ensue, as it did in Great Britain, after similar changes in the tariff were made, would tend to increase the consuming power of our own people in respect to the dutiable goods from which we should still derive a constantly increasing revenue. In this way we might gain a true protection to our domestic industry and the development of our home market; we might then take the paramount position in manufacturing arts as well as in agriculture to which we are entitled and yet enjoy the full benefit of low price and high wages.

I have endeavored to bring out this point very conspicuously, because many persons have looked upon those who are stigmatized as free-traders as if they advocated radical and injudicious changes in our revenue system, such as would launch us upon free trade without warning and without preparation. It is time to lay aside such prejudice with regard to those who advocate tariff reform in the direction of freer trade. I can not name a man among my associates in the study of these economic questions whose views are not substantially like my own and who is of any considerable influence or importance either as a student, economist, or legislator —not one who would not deprecate radical and revolutionary changes and who would not be guided by the most conservative ideas in the measures by which an ultimate but very profound change in our fiscal system would be brought about.

So far as one may judge by the course which has been taken in the House of Representatives and in the Senate, and by the position taken by ex-President Cleveland, the advocates of tariff reform and reduction first declared their adhesion to this proposed method by putting wool, hemp, flax, and many other articles which are most important products in the specific States from which they have been elected at once into the free list. May not men like the representatives from Texas, Kentucky, Tennessee, and Arkansas, who led off in the Committee of Ways and Means in taking off the taxes from wool, hemp, and flax, well be sustained in the brave stand which they have taken and on the lines on which they have carried their constituents with them? These men have also been willing, even eager, to grant rates of duty

on finished fabrics, such as might allay the fears of those who have been so long sustained by high duties that they dread any change. This is a reasonable method. The matter of importance is that we should be headed in the right direction. The time covered in the process of change may well correspond substantially with the life of the existing machinery which has been put at work at the high cost due to past and present conditions. All the machinery in our textile factories has cost at least fifty per cent if not seventy-five per cent more than that of our competitors in England, France, and Germany, on account of the tax upon materials of which that machinery is made. The life of machinery which is used in modern manufacturing ranges from ten to twenty years, averaging perhaps fifteen years. If the relief could at once be given by a removal of the duties upon crude and partly finished materials, with very moderate reduction on the finished goods, we should probably repeat the experience of Great Britain, and we should find, as Gladstone put it, that "the road to free trade is like the road to virtue; the first step the most painful, the last step the most profitable."

The manufacturers of England were formerly so afraid of pauper labor, so called, that when the proposition for the union of Ireland with England was pending, the purport of which was of course to bring Ireland under the same tariff system as that of England, they sent memorials to Parliament in opposition to the union, on the ground that they would be ruined by the cheap labor of Ireland. Of course, they were disappointed; they were not obliged to disturb or stop the factories of Lancashire and of Yorkshire, or to move them across the Channel. The manufacturers of England soon found out that the low-priced labor of people verging on pauperism is the dearest and not the cheapest labor that can be offered.

I will now close this over-long treatise upon the Method of Tariff Reform by submitting what may be called a practical budget. The figures are based upon the actual accounts of the Treasury of the United States, and upon what is hoped may be the maximum expenditure that will be warranted even by the present Congress.

First let me call attention to a few facts. Let us suppose that the civil war were ended—I mean the financial war, which will not be ended until the last dollar of debt shall have been paid and the last pension shall have fallen in. There are certain necessary annual appropriations which must be met year by year. How could we meet them with the least interference with the freely chosen pursuits of the people, and yet with due regard to the conditions in which we are? The ordinary expenses consist of, first, the cost of the civil service, legislative, judicial, consular, and the

like, and the cost of the collection of revenue; second, the support of the army and the construction of fortifications; third, the support of the navy, without expensive appropriations for construction; fourth, the deficiency in the postal service; fifth, the interest on the public debt; sixth, the support of the Indians; and seventh, the miscellaneous expenses. The sum of these regular or normal expenditures, aside from war obligations, according to the estimates submitted by the Secretary of the Treasury for the next fiscal year, which estimates until now have been more apt to be cut down than increased by Congress, amount to less than $200,000,000. We may set off a tax against each branch of expenditure, and the conclusion which we reach is rather singular.

Omitting fractions, the internal revenue from whisky more than pays the cost of the civil government. The excess added to the tobacco tax more than suffices to pay the army expenses and fortifications. The navy floats on beer, with a part of the beer tax to spare and carry forward. The income from the Indian trust funds meets the cost of the Indian Department. The miscellaneous permanent receipts of various kinds more than cover the miscellaneous permanent expenses; while the sugar tax and the revenue derived from imported liquors and tobacco cover the postal deficiency and the interest on the public debt, with $10,000,000 to spare.

Were it not for pensions and sinking funds, our pleasant vices, with the tax on sugar added, would support the Government on a very adequate scale, not very economically administered, and with a margin for contingencies of more than $10,000,000 to spend on rivers and harbors.

This is only one way of putting the case. It shows how easily we could cover all the normal or peace expenditures of the Government by taxing nothing but spirits, beer, tobacco, and sugar. But we are subject to war expenses and we must continue some war taxes for a term of years. We may therefore make up two accounts:

No. 1.

War Expenses:	
Current annual pensions, $65,000,000; arrears, $35,000,000	$100,000,000
Interest on war debt	31,500,000
Sinking fund	48,500,000
Total war expense	$180,000,000
War Taxes:	
Internal tax on whisky	$78,000,000
Internal tax on beer	27,000,000
Internal tax on tobacco	33,000,000
Duties on sugar and molasses	60,000,000
Elasticity in next fiscal year	2,000,000
Total war taxes	$200,000,000
Excess of war revenue carried forward	$20,000,000

No. 2.

Peace Expenditures:		
Civil service		$66,000,000
Army and fortifications		37,000,000
Navy		25,000,000
Indians		6,000,000
Postal deficiency		7,000,000
Miscellaneous		21,000,000
Rivers and harbors		10,000,000
Total		$173,000,000
Peace Revenue on Present Basis:		
Brought forward from the war taxes		$20,000,000
Miscellaneous permanent receipts, omitting so-called profit on silver coinage		30,000,000
Customs revenue on basis of calendar year ending December 31, 1889	$230,000,000	
Less sugar assigned to war expenses	60,000,000	
		170,000,000
Total		$220,000,000
Surplus available for reduction of taxation		47,000,000

On reference to the table of the revenue derived from imports, sorted according to their kind, given in the first part of this treatise, it will be found that—

Aside from sugar, necessary articles of food have been taxed annually between $10,000,000 and		$12,000,000
Articles in a crude condition necessary in the processes of domestic industry.	$13,000,000 to	14,000,000
Articles partly manufactured which are necessary in the processes of domestic industry	$23,000,000	
Less some duties which are imposed in order to adjust other duties to the internal taxes, etc	3,000,000	
		20,000,000
Total		$46,000,000

All this revenue can be spared. All these taxes are a useless burden upon domestic industry. This relief can be given within the surplus proved to exist, if this Congress does not waste the substance of the people in order to prevent a reduction of taxation.*

Of course, one can not enter into details in a magazine article. Judgment would be required in abating the duties upon crude and partly manufactured materials. Under these headings there may be a very few articles which it may be necessary to move

* Since this treatise was first prepared for submission to a private club, the dependent pension bill has been passed, which may increase the current annual obligation to $100,000,000 a year. If common sense ruled in fiscal legislation, a duty on tea and coffee would have been imposed to meet this increased obligation. But even this new burden will not prevent the application of this budget within two or three years by the next Congress—such is the elasticity of our revenue, in spite of all the stupidities of partisan legislation.

into another class, or on which duties would have to be maintained because of their close relation to finished products of a very similar kind. So long as we maintain a duty upon spool cotton, for instance, it would not be safe or judicious to remove all duties upon fine cotton thread which could be imported in the skein and reeled here. But these are all small matters of detail. Suffice that the revenue which is now derived from spirits, tobacco, beer, and sugar, from silks, furs, and fancy goods, and from laces, embroideries, and the fine textile fabrics which are articles of luxury rather than of utility, is so large that it would suffice to meet all the ordinary and all the extraordinary expenditures of the Government.

But there is another element to be considered. When a reform of the English tariff was laid down on these lines under the direction of Sir Robert Peel, even he could not anticipate the prosperity which would ensue from the removal of the little petty obstructions to the commerce of the globe, which had yielded only a small part of the customs revenue. He expected a deficiency in the revenue from the duties on imports in consequence of the abatement of the duties on the articles made free; and to meet this expected deficiency he carried a temporary income tax for three years, beginning in 1842 to end in 1845. But such was the stimulus given to industry, trade, and commerce with all the world, that the revenue on dutiable imports soon rose to the same amount that had been yielded before the reform. By 1845 the previous deficiency in the revenue had been surmounted and the Treasury of Great Britain had a surplus to dispose of for the first time in many years.

But the lesson had been learned. Opposition to tariff reform almost ceased; in 1845 another list of articles of more importance was added to the free list. Still it could not be conceived that the revenue would not be diminished and the income tax was again imposed for the term of three years. But again the revenue from dutiable imports increased rapidly, again the consuming power of the people had increased with their prosperity. Then came the Irish famine. The corn laws went by the board by Orders in Council, afterward justified by act of Parliament. The prosperity of England went forward by leaps and bounds. And in 1853 Gladstone completed the work that Peel had begun.

We have yet to learn how to increase the public revenue by the abatement of obnoxious and obstructive taxation; even the simple system which is herein presented, under which even an excessive expenditure can be met by a very simple system of taxation, under which every necessary article in our domestic manufactures will be free could it be put in force, would be immensely disappointing, and in the same way in which Peel and his coadjutors

were disappointed. The mass of the people, who are the great consumers both of domestic and of foreign products, would gain so much in their consuming power as to cause the revenue from dutiable imports to become greater than it had ever been before, even if we take off fifty million dollars of taxes now derived from such foreign imports as have been named above.

Again, while the ordinary expenditures of the Government may increase with the population, the burden of interest and of pensions will soon rapidly diminish; therefore I am justified in predicting that if this policy should be adopted and continue for fifteen years or during the life of existing machinery, in which interval all our processes of manufacturing would be readily adapted to the new conditions at a diminishing cost, we might then, if we chose, relieve every article of import from foreign countries from taxation, except spirits, beer, tobacco, and sugar, and perhaps relieve sugar by substituting some other less onerous tax, as the people of Great Britain have done within a very few years.

We might come to these conditions sooner if it were expedient, provided the mass of the people could be persuaded to put a moderate duty on tea and coffee as a substitute for duties on some other commodities. This, however, can hardly be expected; the great objection to the present removal of the duty on sugar is that, once off, it would be difficult to put it on again even if the public should become convinced that they had better put a tax on sugar than on wool, hides, lumber, leather, tin plates, salt fish, potatoes, and other articles of like kind.

Strange as it may seem, a small part of the members of the Senate and House of Representatives seem to believe that the dogma of "protection with incidental revenue" has some foundation in right and justice—notably the author of this catch-word or phrase, who has been pushed into temporary prominence as Chairman of the Committee of Ways and Means by the very sincerity of his convictions.

The greater part of the support of this measure is, however, given by the mis-representatives of their respective States, who can only be designated as political lacqueys or time-servers, many of whom are known to vote against their own convictions.

It happens that most of the representatives on the Democratic side who have not heretofore agreed with the majority of their own number upon this question, have either been removed by death or by failure to be re-elected. Hence comes the necessity for a choice of parties, if this question is to be the paramount one in politics. It is a pity, even a shame, that a plain, practical business question can not be taken out from party politics to be settled on its merits. What is there that we can do to bring this about? This is a meeting of representative business men who have here-

tofore voted, some with one party, some with another. Some are called protectionists, some are classed as free-traders, yet all may come to a practicable agreement on practical methods of tariff reform. If that agreement could be brought into effect both here and elsewhere, to the end that every candidate for election to Congress or to the Senate of the United States, whether named Republican or Democratic, would be given to understand that his election would depend upon his giving his support to methods of tariff reform which are consistent with common sense, such as I have attempted to bring before you, we might feel perfectly sure that the average candidate on either side would hasten to get the benefit of the first conversion to these views.

In the great struggle by which personal liberty was established, the men at arms knew no difference between Republican and Democrat. Loyalty to the principle of liberty was the sole test by which men were justified or condemned. May we not establish the same test in the struggle for relief from the burden of obstruction and destructive taxation?

When in the fullness of time, with due preparation, with careful consideration, and with consistent regard to all existing conditions, the object may be attained which is aimed at by every intelligent protectionist, tariff reformer, and free-trader alike; when all the conditions precedent have been safely established on the lines upon which we may now enter—we may begin the next century free from slavery, free from debt, free from destructive taxation, free from the cruel burden of great standing armies and navies. Then may the people of Massachusetts and all her sister States conduct their work and serve all nations as they serve themselves, sustained and governed by the principle which is engraved upon her own great seal:

Ense petit placidam sub libertate quietem.

[*Concluded.*]

SOME NATIVES OF AUSTRALASIA.*

By ELISÉE RECLUS.

TAKEN collectively, the Dayak populations differ from the civilized Malays by their slim figure, lighter complexion, more prominent nose, and higher forehead. In many communities the men carefully eradicate the hair of the face, while both sexes file, dye, and sometimes even pierce the teeth, in which are fixed gold buttons. The lobe of the ear is similarly pierced for the insertion of bits of stick, rings, crescent-shaped metal plates,

* From Oceanica, the fourteenth volume of Reclus's great illustrated work on The Earth and its Inhabitants, now in course of publication by D. Appleton & Co.

and other ornaments, by the weight of which the lobe is gradually distended down to the shoulder. In several tribes the skulls of the infants are artificially deformed by means of bamboo frames and bandages.

The simple Dayak costume of blue cotton with a three-colored stripe for border is always gracefully draped, and the black hair is usually wrapped in a red cloth trimmed with gold. Most of the Dayaks tattoo the arms, hands, feet, and thighs, occasionally also the breast and temples. The designs, generally of a beautiful blue color on the coppery ground of the body, display great taste, and are nearly always disposed in odd numbers, which, as among so many other peoples, are supposed to be lucky. Amulets of stone, filigree, and the like, are also added to the ornaments to avert misfortune. In some tribes coils of brass wire are wound round the body, as among some African peoples on the shores of Victoria Nyanza.

Many Dayak tribes are still addicted to head-hunting, a practice which has made their name notorious, and which but lately threatened the destruction of the whole race. It is essentially a religious practice—so much so that no important act in their lives seems sanctioned unless accompanied by the offering of one or more heads. The child is born under adverse influences unless the father has presented a head or two to the mother before its birth. The young man can not become a man and arm himself with the *mandau*, or war-club, until he has beheaded at least one victim. The wooer is rejected by the maiden of his choice unless he can produce one head to adorn their new home. The chief fails to secure recognition until he can exhibit to his subjects a head secured by his own hand. No dying person can enter the kingdom beyond the grave with honor unless he is accompanied by one or more headless companions. Every rajah owes to his rank the tribute of a numerous escort after death.

Among some tribes, notably the Bahu Trings, in the northern part of the Mahakkam basin, and the Ot-Damons of the upper Kahajan, the religious custom is still more exacting. It is not sufficient to kill the victim, but before being dispatched he must also be tortured, the corpse sprinkled with his blood, and his flesh eaten under the eyes of the priest and priestesses, who perform the prescribed rites. All this explains the terror inspired by the Dayaks in their neighbors, and the current belief that they are sprung from swords and daggers that have taken human form. With the gradual spread of Islam the Dayaks of the British and Dutch possessions are slowly abandoning their bloodthirsty usages. At the same time the head-hunters themselves, strange to say, are otherwise the most moral people in the whole of Indonesia. Nearly all are perfectly frank and honest. They scru-

FIG. 1.—DAYAK TYPES, BORNEO.

pulously respect the fruits of their neighbors' labor, and in the tribe itself murder is unknown.

The population of New Guinea, variously estimated at from half a million to two millions, comprises a very large number of groups differing greatly from each other in stature, complexion,

shape of the skull, and other physical features, as well as in their usages and mental qualities. Several tribes approach the Indonesian type, as found in Borneo and Celebes, while others resemble the Malays, and are described by travelers as belonging to this race. But, although there is no ethnical uniformity, as seemed probable from the reports of the early explorers, the Papuan element, whence the great island takes the name of Papuasia, certainly predominates over all others.

On the whole the Papuans are somewhat shorter than the Polynesians, the average height being about sixty-two to sixty-four inches. They are well proportioned, lithe, and active, and display surprising skill both in climbing trees and in using the feet for prehensile purposes. Most Papuans have a very dark skin, but never of that shiny black peculiar to the Shilluks of the White Nile, the Wolofs of Senegal, and some other African peoples. The eyebrows are well marked, the eyes large and animated, the mouth large but not pouting, the jaw massive. Among the northwestern Papuans, regarded by Wallace as representing the type in its purity, the nose is long, arched, and tipped downward at the extremity, and this is a trait which the native artists never fail to reproduce in the human effigies with which they decorate their houses and boats. Another distinctive characteristic of numerous tribes is their so-called mop-heads, formed by superb masses of frizzly hair, no less abundant than that of the Brazilian Cafusos, and, as in their case, possibly indicating racial interminglings.

However backward they may be in other respects, most of the Papuans are endowed with a highly developed artistic feeling, and as carvers and sculptors they are far superior to most of the Malayan peoples. Having at their disposition nothing but bamboos, bone, banana-leaves, bark, and wood, they usually design and carve with the grain—that is, in straight lines. Nevertheless, with these primitive materials they succeed in producing extremely elegant and highly original decorative work, and even sculpture colossal statues representing celebrated chiefs and ancestors. Thanks to this talent, they are able to reproduce vast historic scenes, and thus record contemporary events. Numerous tribes have their annals either designed on foliage or depicted on rocks in symbolic writing. The skulls of the enemies slain in battle, which are carefully preserved to decorate the houses, are themselves often embellished with designs traced on masks made of wax and resin. On the banks of the Fly River these skulls are also used as musical instruments.

The island of Tasmania has already been completely "cleared" by the systematic destruction of its primitive inhabitants, who were estimated at about seven thousand on the arrival of the

whites, and who were said to be of a remarkably gentle and kindly disposition. On December 28, 1834, the last survivors, hounded down like wild beasts, were captured at the extremity of a headland, and this event was celebrated as a signal triumph. The successful hunter, Robinson, received a government reward of six hundred acres and a considerable sum of money, besides a public subscription of about eight thousand pounds.

The captives were at first conveyed from islet to islet, and then confined to the number of two hundred in a marshy valley of Flinders Island, washed by the stormy waters of Bass Strait. They were supplied with provisions and some lessons in the catechism; their community was even quoted as an example of the

FIG. 3.—LALLA ROOKH, THE LAST TASMANIAN.

progress of Christian civilization. But after ten years of residence in this place of exile more than three fourths of the natives had perished. Then pity was taken on them, and the twelve surviving men, twenty-two women, and ten children, nearly all half-breeds, were removed to a narrow promontory at Oyster Cove, near Hobart, and placed under some keepers, who enriched them-

selves at their expense. In 1860 the Tasmanian race was reduced to sixteen souls; in 1869 the last man perished, and in 1876 "Queen" Truganina, popularly known as Lalla Rookh, followed her people to the grave. But there still survived a few half-castes, and in 1884 a so-called "Tasmanian" woman obtained a grant of land from the Colonial Parliament.

The Fijians present affinities both with the western Melanesians and eastern Polynesians, and are at least partly of mixed descent, although the majority approach nearest to the former group. They are tall and robust, very brown and coppery, sometimes even almost black, with abundant tresses intermediate between hair and wool. Half-breeds are numerous and are often distinguished by almost European features. Till recently they went nearly naked, wearing only the loin-cloth or skirt of vegetable fiber, smearing the body with oil, and dyeing the hair with red ochre. The women passed bits of stick or bark through the pierced lobe of the ear, and nearly all the men carried a formidable club; now they wear shirts, blouses, or dressing-gowns, or else drape themselves in blankets, and thus look more and more like needy laborers dressed in the cast-off clothes of their employers. They display great natural intelligence, and, according to Williams, are remarkable for a logical turn of mind, which enables Europeans to discuss questions with them in a rational way. Their generosity is attested by the language itself, which abounds in terms meaning *to give*, but has no word to express the acts of borrowing or lending. Compared with their Polynesian neighbors, they are also distinguished by much reserve. Their *meke*, or dances, always graceful and marked by great decorum, represent little land or sea dramas, sowing, harvesting, fishing, even the struggles between the rising tides and rocks.

Cannibalism entered largely into the religious system of the Fijians. The names of certain deities, such as the "god of slaughter," and the "god eater of human brains," sufficiently attest the horrible nature of the rites held in their honor. Religion also taught that all natural kindness was impious, that the gods loved blood, and that not to shed it before them would be culpable; hence those wicked people who had never killed anybody in their lifetime were thrown to the sharks after death. Children destined to be sacrificed for the public feasts were delivered into the hands of those of their own age, who thus served their apprenticeship as executioners and cooks. The banquets of "long pig"—that is, human flesh—were regarded as a sacred ceremony from which the women and children were excluded; and while the men used their fingers with all other food, they had to employ forks of hard wood at these feasts. The ovens also in which the bodies were baked could not be used for any other purpose. Notwith-

standing certain restrictions, human flesh was largely consumed, and in various places hundreds of memorial stones were shown which recalled the number of sacrifices.

FIG. 4.—TATTOOED NATIVE OF THE MARQUESAS ISLANDS.

From the ethnical standpoint Polynesia forms a distinct domain in the oceanic world, although its inhabitants do not appear to be altogether free from mixture with foreign elements. The vestiges of older civilizations differing from the present even prove that

human migrations and revolutions have taken place in this region on a scale large enough to cause the displacement of whole races. The curious monuments of Easter Island, although far inferior in artistic work to the wood-carvings of Birara and New Zealand, may perhaps be the witnesses of a former culture, no traditions of which have survived among the present aborigines. These monuments may possibly be the work of a Papuan people, for skulls found in the graves differ in no essential feature from those of New Guinea.

The Polynesians, properly so called, to whom the collective terms Mahori and Savaiori have also been applied, and who call themselves Kanaka, that is, "men," have a light-brown or coppery complexion, and rather exceed the tallest Europeans in stature. In Tonga and Samoa nearly all the men are athletes of fine proportions, with black and slightly wavy hair, fairly regular features, and proud glance. They are a laughter-loving, light-hearted people, fond of music, song, and the dance, and where not visited by wars and the contagion of European "culture," the happiest and most harmless of mortals. When Dumont d'Urville questioned the Tukopians as to the doctrine of a future life, with rewards for the good and punishment for the wicked, they replied, "Among us there are no wicked people."

Tattooing was wide-spread, and so highly developed, that the artistic designs covering the body served also to clothe it; but this costume is now being replaced by the cotton garments introduced by the missionaries. In certain islands the operation lasted so long that it had to be begun before the children were six years old, and the pattern was largely left to the skill and cunning of the professional tattooers. Still, traditional motives recurred in the ornamental devices of the several tribes, who could usually be recognized by their special tracings, curved or parallel lines, diamond forms, and the like. The artists were grouped in schools, like the Old Masters in Europe, and they worked not by incision as in most Melanesian islands, but by punctures with a small, comb-like instrument slightly tapped with a mallet. The pigment used in the painful and even dangerous operation was usually the fine charcoal yielded by the nut of *Aleurites triloba*, an oleaginous plant used for illuminating purposes throughout eastern Polynesia.

In Samoa the women were much respected, and every village had its patroness, usually the chief's daughter, who represented the community at the civil and religious feasts, introduced strangers to the tribe, and diffused general happiness by her cheerful demeanor and radiant beauty. But elsewhere the women, though as a rule well treated, were regarded as greatly inferior to the men. At the religious ceremonies the former were

FIG. 5.—SAMOAN WOMEN.

noa, or profane; the latter *ra*, or sacred; and most of the interdictions of things *tabooed* fell on the weaker sex. The women never shared the family meal, and they were regarded as common property in the households of the chiefs, where polygamy was the rule. Before the arrival of the Europeans, infanticide was systematically practiced; in Tahiti and some other groups there existed a special caste, among whom this custom was even regarded as a duty. Hence, doubtless, arose the habit of adopting strange children, almost universal in Tahiti, where it gave rise to all manner of complications connected with the tenure and inheritance of property.

In Polynesia the government was almost everywhere centered in the hands of powerful chiefs, against whose mandates there was no appeal. A vigorous hierarchy separated the social classes one from another, proprietors being subject to the chiefs, the poor to the rich, the women to the men; but over all custom reigned supreme. This law of *taboo*, which regulated all movements and every individual act, often pressed hard even on its promulgators, and the terrible penalties it enforced against the contumacious certainly contributed to increase the ferocity of the oceanic populations. Almost the only punishment was death, and human sacrifices in honor of the gods were the crowning religious rite. In some places the victims were baked on the altars, and their flesh, wrapped in taro-leaves, was distributed among the warriors.

Yet, despite the little value attached to human life, the death of adult men gave rise to much mourning and solemn obsequies. Nor was this respect for the departed an empty ceremonial, for the ancestors of the Polynesians were raised to the rank of gods, taking their place with those who hurled the thunderbolt and stirred up the angry waters. A certain victorious hero thus became the god of war, and had to be propitiated with supplications. But the common folk and captives were held to be "soulless," although a spirit was attributed to nearly all natural objects.

In his book on The Cradle of the Aryans, Prof. Rendall takes the position of an independent critic. Reviewing the theories that have been offered, and the arguments, both in favor of an Asiatic and of a European origin, he concludes that the portion of the white race to which the Indo-European languages properly belong had its first home in southern Scandinavia, and is best represented by the Swedes and Norwegians of the present day. Father Van den Gheyn, on the other hand, in his recently published pamphlet, L'Origine Européenne des Aryas, sums up the discussion from the point of view of the old theory of a home in the basin of the Oxus and Jaxartes. M. Reinach, reviewing his book, opposes the idea of a European home, but commits himself no further than to say that the spot is "somewhere in Asia."

KING BOMBA'S PHILOSOPHICAL CATECHISM.

By Prof. E. P. EVANS.

THE proper education of a prince and heir to the throne has been regarded from time immemorial as one of the most perplexing problems of pedagogics. Especially in the past ages of absolutism, when the monarch was the source of all authority, it was a matter of immense importance that the man whose will was to be the law of the land, and upon whose merest whim the weal or woe of a whole people depended, should, as a child, be trained up in the way he should go, and, as an adult, should not be permitted to depart from it.

In the Orient, where the sovereign was revered as a demi-divine incarnation and plenipotentiary delegate from heaven for the administration of justice on earth, he was also supposed to be supernaturally endowed with wisdom from on high—a pleasing fiction, which still survives in the claims of kings to wear their crowns and wield their scepters "by the grace of God." As a natural sequence of this theory, scions of royal stock were confided to members of the sacerdotal order for their education. In India the Brahman claimed for his caste all posts of honor and emolument in the realm, and all positions of influence near the person of the ruler. Not only was it deemed essential to the power and permanence of the dynasty that he should perform the duties of court priest (*purohita*), but he also arrogated to himself the functions of court fool (*vidûshaka*); in his overweening ambition and insatiable greed of supremacy, he could bear no rival near the throne, even though the competitor were a man of motley.

It was likewise the privilege of the Brahman to be pedagogue in perpetuity to the royal family. His son or some member of his caste was as sure of succeeding to the ferule as the king's son or some prince of the blood was of inheriting the scepter; and, judging from what we know of the manuals of instruction, in which his teachings were embodied, he was eminently worthy of his high office. Thus the Hitopadesá was composed or rather compiled by Vishnu Sárman for several young princes who were his pupils; and it would be difficult to find in the whole vast range of didactic literature any work containing in the same compass a greater sum of homely wisdom and a larger number of prudential maxims and ethical rules for the conduct of life than are compressed into this little treatise on deportment, or *nîtividyâ*, a word which the modern masters of this science would translate by *savoir vivre*. This Kind Counsel, as the title Hitopadesá signifies, is illustrated and enforced by a series of fables and kindred

stories, skillfully woven together into a consecutive narration, which has remained for centuries the unsurpassable model of all productions of a like character. In Greek literature we have Xenophon's Cyropædia, which gives an imaginary picture of the education of the elder Cyrus, in order to present the ideal of a prince whose moral and intellectual faculties have been developed according to the principles of the Socratic philosophy. Less worthy of note, and yet not devoid of significance, is the De Clementia ad Neronem Cæsarem of Seneca, whose imperial pupil Nero does not redound to his credit as a tutor, and whose own conduct did not always exemplify his fine ethical maxims. In the sixteenth century Duke Julius, of Brunswick, began with his Deutscher Fürstenspiegel the fabrication of those moral mirrors in which princes are enabled to see themselves as others see them.

The Prince of Machiavelli is a different kind of production, being less a pedagogical than a political treatise—not so much an exposition of ethical principles as an enforcement of practical policy. It is the final, energetic effort of a sincere patriot to rescue his country from the demoralizing and disintegrating influences, aristocratic, democratic, and hierarchical, which made it the prey of factions from within and foreigners from without. If the remedy prescribed is drastic, the disease was also desperate.

Of all modern works belonging to the class under consideration, The Adventures of Telemachus, written by Fénelon for the instruction and guidance of the grandsons of Louis XIV, holds perhaps the highest place in literature. But the ideal of conduct, which the Archbishop of Cambrai here offers for imitation, is so pure and exalted, that the king regarded the book as a satire on his reign and forbade its publication. It was also the common opinion of his courtiers that Calypso was the Marquise de Montespan, Antiope the Duchesse de Bourgogne, and Sesostris no less a personage than the Grand Monarch himself. No one, nowadays, in reading Fénelon's masterpiece of fiction, thinks of the didactic purpose for which it was written; we are attracted solely by the charm of style and the perfection of artistic form which have made it classic.

Very different in this respect is the notorious Philosophical Catechism collaborated by King Ferdinand II and Monsignore Apuzzo, Archbishop of Sorrento, for the use of the Hereditary Prince and of the Most Faithful People of the Two Sicilies. This book, which appeared in 1850, was written to justify the perfidies and perjuries of King Bomba, and also, *ad usum Delphini*, to inculcate and perpetuate the principles of monarchical absolutism.

After the suppression of the Revolution of 1848, and the abrogation of the reforms which this movement had temporarily effected, the sovereign of the Two Sicilies began to manifest an

extraordinary interest in diffusing what he deemed useful information among his benighted subjects. He made a Collection of Good Books in favor of Truth and Virtue, in which the doctrine of the divine right of kings and the duty of passive obedience on the part of their subjects were taught in the most emphatic terms. These cheaply printed pamphlets and little volumes were scattered broadcast over the country; but as the great majority of the people were unable to read them, owing to the general illiteracy which his system of government had produced, the priests were instructed to communicate the contents of them to their parishioners, and to make the ideas contained in them the subject of frequent discourse. His Majesty also caused to be published a New Philosophic-Democratic Vocabulary indispensable to every one who desires to understand the New Revolutionary Language, in which the logic of the Holy Office is combined with the rhetoric of the barracks and of Billingsgate to heap contempt upon liberal opinions. But the famous series reaches its climax in the aforementioned Catechism, the *capolavoro* of Monsignore Apuzzo, who, to the exercise of his archiepiscopal functions, added the sinecure of Superintendent of Public Instruction and the confidential post of tutor to the crown prince.

In the preface the author addresses himself directly to "princes, bishops, magistrates, instructors of youth, and all men of goodwill," and enjoins upon them to use their authority, their money, and their influence to secure the widest possible distribution of his work. Those who have control of the public funds in the cities of the realm, he says, should apply them generously and systematically to this worthy end, and assures these officials that God will bless their pious embezzlements.

The following is a translation of the first chapter, which treats of Philosophy:

"*Disciple.* What is philosophy?

"*Master.* It is the science of truth, or rather the science which teaches us to distinguish truth from error.

"*D.* Is it necessary to teach this science to very young persons?

"*M.* It would not be necessary, since they would learn it gradually from experience and from the words and writings of honest and wise men; but at the present time it is necessary that Christian teachers should begin early to instruct their pupils in the true philosophy, in order that they may not learn from others a perverse and false philosophy.

"*D.* Why is it that some persons wish to teach a wicked philosophy, and desire to diffuse error rather than truth?

"*M.* Because they are vicious and bad, and wish that all other men should become vicious and bad.

"*D.* Who are those who teach a false and perverse philosophy?

"*M.* They are the liberal philosophers.

"*D.* Would it not be well to massacre all these corrupters and deceivers of the human race?

"*M.* No, my son; we should detest their errors, but should regard their persons with the eye of charity, pray God to convert them, pardon the offenses which they commit, do good to them, and succor them in their necessities. These are the doctrines of Christianity, and we should show what a difference there is between the followers of the liberal philosophy and the followers of the gospel.

"*D.* What are the effects of the doctrines taught by the liberal philosophers?

"*M.* They cause the decay of religion, bring disaster upon the state, produce the slaughter of war, the weeping of mothers, and the general misery of the people, as may be seen in all those countries whose inhabitants have let themselves be led astray by these fatal and foolish notions. And, above all, they cause the eternal damnation of souls, because he who lives contrary to the law of God on earth can not expect anything but hell in the next world.

"*D.* Are all liberals wicked in the same degree?

"*M.* Not all, my son, because some are willful deceivers, and others are wretchedly deceived; nevertheless, they all go the same way, and, if they do not turn from this path, will all reach the same goal.

"*D.* How are liberal philosophers to be recognized?

"*M.* When you see any one who keeps away from the sacraments and the religious services, who does not go to church, or, if he sometimes goes there, acts irreverently and disrespectfully, who ostentatiously neglects to take off his hat before the images of Jesus Christ and the saints, and is ashamed to be seen making the sign of the cross; when you hear any one joking about heaven and hell, speaking evil of the prince or of the government, deriding priests and friars and ecclesiastical persons; when, finally, you perceive any one who is glad to learn of the progress of rebellions and the success of rebels, and who disapproves of the vigorous acts of the legitimate authorities, and receives with signs of sorrow news favorable to the preservation of religion, of the sovereign power, and of public tranquillity—then you can say for certain that all these are liberal philosophers.

"*D.* Are all those who wear whiskers and full beards liberal philosophers?

"*M.* Not all, because many people merely follow the fashion in wearing the beard.

"*D.* Are not young men, then, permitted to follow the fashion?

"*M.* When the fashions are neither obscene nor ridiculous,

each one is free to follow them if he sees fit, provided, however, that such or such a fashion may not be generally recognized as a mark of adhesion to a bad class. The garb of a hangman or of an assassin may not be scandalous in itself, but no honorable and respectable man would clothe himself as an assassin or hangman in order to be in fashion. In like manner wise and Christian persons ought to be ashamed to imitate in their apparel the liberals and liberal philosophers, and, for this reason, whoever nowadays under the pretext of adapting his dress to the mode plasters his face with those demi-periwigs, shows signs of little honesty, or at least of little sense."

This is a fair specimen of the puerility of the archbishop's reasoning. He then proceeds to discuss the origin and nature of human society, which, he maintains, is a divine institution, and began to exist essentially in its present constitution with the creation of man. The theory of a primitive state of savagery, out of which the race was gradually evolved, he denounces as a figment of the imagination, having no more reality than the dog with seven heads or the sea-creature half fish and half maiden described by the poets. "Modern philosophers, for their own base ends, have feigned to believe in such a state of nature, as they call it, whereas it should be called a state contrary and repugnant to nature." The moral which the Right Reverend Apuzzo draws from his doctrine is, that society being an institution established by God, man has no right to change it under the pretext of reform or by the force of revolution, thus impiously endeavoring, by overturning the thrones of divinely appointed kings, and subverting the social, civil, and religious arrangements which God has ordained, to improve upon the wisdom of the Omniscient.

As regards liberty, he says it would be madness and blasphemy to maintain that the freedom of the gospel has anything in common with the freedom preached by modern philosophers. What the redemption of Christ freed man from was the condemnation and slavery of sin, and from the dominion of the devil. "Before his advent, demons tormented and afflicted the human race in a thousand ways, but Jesus Christ so effectually released mankind from that scourge, and so conquered the power of hell, that nowadays one scarcely knows that there are any such creatures as demons." Was ever any utterance of even the clerical mind more *naïve* than this! All aspirations and struggles for a freedom differing from his definition of the freedom of the gospel he denounces as destructive of human happiness and offensive to the Saviour of the world.

In the chapter on equality, we are told that men are tall, short, smart, stupid, learned, ignorant, virtuous, vicious, rich, poor, strong, and feeble, and that it is therefore impossible for them

to be all equal. Equality before the law, with which liberal philosophers seek to flatter the vanity and excite the passions of the populace, is also a chimera. To punish all persons equally for the same overt acts would be manifestly unjust. Throwing a handful of mud at a common laborer should not be visited with as severe a penalty as throwing a handful of mud at a nobleman, because in the case of the laborer the act only occasions a slight inconvenience, while in the case of the nobleman it involves a grievous insult. By such plausible but wholly impertinent illustrations the shrewd archbishop seeks to shirk the main principle, and to impose upon the simple-minded, who may not have wit enough to detect the fallacies of his reasoning, and to perceive that equality before the law does not imply the necessity of ignoring all circumstances, motives, and effects attending a culpable action. He admits, in conclusion, that all men should be equal in the eye of justice, but asserts that "such an equality is already enjoyed by the inhabitants of the whole civilized world, so that there is no need of the liberal philosophers wasting their breath in proclaiming it." If some persons now and then suffer wrong, "this is due to the wickedness of the human heart, and not to any defects of institutions and laws." That it is, however, the object of laws and institutions to restrain the wickedness of the human heart, and that so far as they fail to do this they are defective, is a point wholly ignored.

After the close of the Franco-German War, the cities of the fatherland began to grow with unwonted rapidity, and many persons of the baser sort became owners of urban habitations, and in their pride of acquisition waxed exceedingly arrogant. A citizen of Munich, who had suddenly risen from the low estate of a handicraftsman to the dignity of a householder, posted up in the lower halls of his tenements a long list of printed rules and regulations to be observed by his tenants, who were not only informed when they must clean and light the stairs, and when they might or might not play on musical instruments, but also received definite and minute instructions touching their personal relations to himself, how they must greet him in passing, and must treat him with proper respect on all occasions. Having specified all the cases which he could think of, and fearing lest any loophole should be left by which obligations might be evaded, he laid down, in a concluding paragraph, the following general principle: "In short, the tenant has no rights, but only duties."

According to Monsignore Apuzzo, God has regulated the universe on the same principle, and man has no rights in opposition to the sovereigns who rule over him, but only duties toward them. "The law of God commands kings and rulers not to be tyrannical and not to oppress their subjects unnecessarily, and thereby guar-

antees to the people all the liberty they can enjoy without disturbing the social order." But as the sovereign alone is to decide what degree of oppression is necessary, and as there is no means of enforcing the law of God in case he sees fit to violate it, this guarantee of the liberty of the people seems to be of the slenderest and filmiest texture.

"The people of themselves have no right to determine what shall be the constitution and fundamental laws of the state, since this would be a limitation of sovereignty, which can not be conditioned and circumscribed except by itself, otherwise it would not be that supreme power established by God for the good of society." Even if a king has sworn to observe the constitution of the realm, he may set it aside if he finds it prejudicial to the exercise of his sovereignty and injurious to the highest interests of the state. "An oath can never be permitted to become a bond of iniquity, or a cause of harm to the people. Besides, the head of the Church has been authorized by God to absolve consciences from oaths, whenever he thinks there are good reasons for doing so. Even if a monarch should violate the constitution and laws of the country inconsiderately and without just cause, universal contempt and censure would be the only possible penalty for such an act. The supreme power may be praised or blamed, but can not be judged or condemned by any other power, since it is supreme. The people must accept the result with resignation, and will lose nothing thereby, because the fundamental laws are the work of man, but the sovereign power is the work of God.

"*D.* But suppose the king burdens his subjects with enormous taxes and squanders the money of the state, would not the revolt of the people be justifiable?

"*M.* No, it would not be justifiable, because the people have no right to judge of the necessities and expenditures of the sovereign, and the Holy Spirit through the mouth of Saint Paul has commanded the people to pay tribute, but has nowhere said that they should audit the accounts of kings.

"*D.* When the king cruelly abuses and does not respect the lives and blood of his subjects, would not revolt and revolution be justifiable?

"*M.* Not at all, because the people are not judges and avengers of injuries done them by private persons, and much less of those inflicted upon them by princes whom God has appointed to rule over them."

As regards freedom of opinion, every man is at liberty to entertain whatever opinions he pleases, and the government can not persecute him on this account, because it has no means of knowing his opinions. But when these secret thoughts and judgments of the mind are expressed in words, whether spoken or written,

they cease to be mere opinions and become overt acts, and are, as such, subject to the scrutiny and control of the public authorities. It is not only the right but also the duty of the supreme power to prevent the promulgation and to punish the diffusion and propagation of false and pernicious opinions, which imperil the existing religious, political, and social institutions. "God did not endow men with speech in order that they might utter absurdities and blasphemies, nor favor the invention of printing in order that it might serve to excite scandals, spread abroad impiety, and stir up the people against the powers that be, which are ordained of him." What kind of opinions are dangerous and injurious, it is, of course, for sovereigns, aided and advised by sacerdotal counselors to decide, and from their decision there is no appeal.

The most perfect form of civilization, according to Monsignore Apuzzo, is the mean between extreme ignorance and excessive knowledge. "Of course it is not meant to inculcate absolute ignorance, and to imply that men of the lower classes should live like beasts and blocks of stone, but that each person should be taught what is suitable to his class, and avoid that superfluity which can only prove harmful and troublesome to him. The Holy Spirit says through the mouth of Saint Paul that one should not know more than is convenient, and should be content to know with moderation, '*non plus sapere quam oportet sapere sed sapare ad sobrietatem*'; and these words of the apostle are addressed not only to the learned, but to men of all classes. For laborers and peasants, moderation consists in knowing the catechism and the vocal prayers, and nothing more. For mechanics and shopkeepers, moderation consists in knowing how to read, write, and cipher a little, and nothing more. For the professional classes, moderation consists in studying merely what pertains to their professions; and for the higher classes, moderation consists in learning what they can, provided they do not abuse the teachings of man by setting them in opposition to the teachings of God. This is what is called knowing soberly, and these are the limits within which the spread of learning, culture, and enlightenment must be kept."

These are the views of a man who was the highest ecclesiastical dignitary and the Superintendent of Public Instruction in the kingdom of the Two Sicilies under Ferdinand II; and this is the sort of sophistical stuff with which the crown prince, who afterward ascended the throne as Francis II, was systematically crammed. His education was entirely in the hands of Jesuits, and it was in this wise that they carried it on. No wonder that, as king, he was a gloomy and narrow-minded bigot, the helpless puppet of priests, utterly alien to the prevailing spirit of the age and the noblest aspirations of his time, and that Garibaldi's mere

presence in southern Italy sufficed to cause his scepter to fall from his impotent grasp.

In the concluding chapters of his Philosophical Catechism our author ridicules love of country as a shallow sentiment, censures patriotism as sedition, burns holy incense under the noses of the score of petty potentates who were then the curse of Italy, praises foreign domination, extols the "loyal and Christian" house of Hapsburg, and even invokes the blessing of heaven upon the Austrian soldiers, and has the impudence to assert that there is not a foot of soil in the whole peninsula that has not been freed and saved by them.

The rapid march of events since 1860 has now made it seem almost incredible that such a work, worthy of the darkest period of the middle ages, should have been written, approved by the Church and the state, and circulated as a public document in southern Italy less than fifty years ago.

It is at present almost impossible to obtain a copy of the original volume; but the people of the Two Sicilies had no sooner achieved their independence than the liberal party at Naples reprinted it as a monument to the deposed Bourbon dynasty—a monument that performs the functions of a pillory.

WILD HORSES.

By Dr. EDOUARD L. TROUESSART.

THE primitive stock of the domestic horse has until recently been considered wholly extinct. A few more or less numerous herds of horses called *tarpans* are living in a state of freedom in the steppes of central Asia, but they are the descendants of domestic horses that have become wild, and do not differ much more from the domestic races of the same country than the half-wild horses of the Landes and of La Camargue, in the south of France, differ from the horse of Tarbes or the Pyrenees.

There are also found in the Asiatic steppes bands of really wild animals, the hemiones, onagras, or fertile mules of the ancients, which are not true horses, but, notwithstanding their shorter ears, more resemble the ass and mule. They are widely scattered in Asia and form three distinct species, of which the best known is the Indian hemione (*Equus hemionus*, var. *onager*), the onagra of Pallas and the ancients, the *ghor khur* of the Hindoos, the *ghour* or *kherdecht* of the Persians, and the *koulan* of the Kirghiz—a species common in zoölogical gardens, where it is easily bred.

It inhabits the Cutch or Indian Desert and the steppes of Tur-

kistan, where the caravans going from Persia to Yarkand often meet numerous droves of these animals. Farther north and east, on the central plateau of Asia, lives the hemione of Thibet (*Equus hemionus* proper), the *kiang* or *disightai* of the Thibetans, which much resembles the preceding animal. Then in the southwest, in the Desert of Syria and the north of Arabia, is found the hemippus (*Equus hemippus* or *E. hemionus Syriacus*), with shorter ears and more elegant forms than the preceding animals. Prof. Henri Milne-Edwards was of the opinion that the three races of hemione were only local varieties of a single species (*Equus hemionus*).

North of the central plateau of Asia, the steppes of Turkistan are prolonged so as to form the Desert of Gobi, and again farther east into the Desert of Dzungaria. This region, situated immediately south of Siberia, from which it is separated by the valley of the Amoor, and north of the Thian-Shan Mountains, which separate it from China, remained almost entirely unexplored till the time when it passed from the dominion of the Chinese to that of the Russians. In this desert region the celebrated traveler Prejevalski discovered in 1881, during his last journey into central Asia, a wild horse distinct both from the tarpan and from the different varieties of the hemione.

The wild horses of this species, called *kertag* by the Kirghiz and *takki* by the Mongols, live in small herds of from five to fifteen individuals, under the direction of an old stallion. They are very suspicious, and rarely allow themselves to be approached within gunshot. They are extremely swift and easily escape the best-mounted hunters. After several fruitless pursuits, Prejevalski succeeded in bringing down a three-year-old stallion, whose remains are now to be seen in the Museum of the Academy of Sciences of St. Petersburg, and which is the type of the *Equus Prejevalskii* of the naturalist Poliakoff.

The wild horse of Dzungaria is an animal the size of the hemione and more robust in its proportions, in which it resembles the pony. Its head is large, with ears smaller than those of the hemione, the shoulders thick, especially in the male, the limbs robust and stubbier than those of the hemiones and the asses. The mane is short and straight, and the moderately long tail is terminated by a tuft of long hairs in much more abundant supply than in the tail of the hemiones. It has warts on the hind-legs as well as on the fore-legs—a peculiarity of the horse, distinguishing it from the other species of the genus, which have warts only on the fore-legs. The hoofs are full like those of the horse, and not compressed as in the other species; and the lower parts of the legs are furnished with long hairs falling to the crown of the hoof, a feature which the hemiones lack. Like-

wise characteristic is the color of the pelage, a pale gray, almost white, passing into dun on the head and neck, and blending insensibly on the flanks with the pure white of the belly and limbs. The mane, the brush of the tail, and the long hairs of the lower legs and hoofs, are black. There is no trace of the dark dorsal stripe running from the mane to the tail which is characteristic of the hemione. The hairy covering is long and undulating, especially in the rigorous winter of that northern region.

The external appearance of the animal, as may be inferred from our drawing (Fig. 1), is very like that of the small horse or

Fig. 1.—Dzungarian Wild Horse (*Equus Prejevalskii*).

pony. It has been assumed, principally on the ground of the form of the tail, that Prejevalski's horse is a hemione. This opinion does not appear to us tenable; it is evidently founded on a begging of the question, because we have so far been ignorant of the real form of the tail of the primitive horse. The study of other wild species of the genus seems to indicate, on the other hand, that the brush form is characteristic of all the wild horses, the plumy tail and mane being acquisitions of domesticity, like the drooping ears of dogs, pigs, and goats. The tail of Prejevalski's horse is, moreover, more brushy than that of the hemiones. Proofs of another kind are derived from paleontology. There are among the representations of *Equidæ* of the Quaternary epoch, engraved by primitive men on reindeer-horn and ivory, discovered by M. Piette in the caves of the south of France, some very clearly representing a horse with a brush tail and short ears like those of the Prejevalski horse.

Furthermore, the light-colored and uniform coating, without the dorsal stripe and not separated by a darker tint from the white of the lower parts; the plump shape of the hoofs, and the long hairs of the lower legs, are so many characteristics separating the Prejevalski horse from the hemiones and allying it with the horse.*

It is therefore reasonable to assume, with Poliakoff, that the wild horse of Dzungaria is the true primitive horse, and represents the original stock of all the domestic races. That naturalist has compared the skull of this horse with those of the remains of horses in the European Quaternary, and has been led to believe in as complete an identity as possible between the two types. We know, from the researches of Nehring on the Quaternary fauna

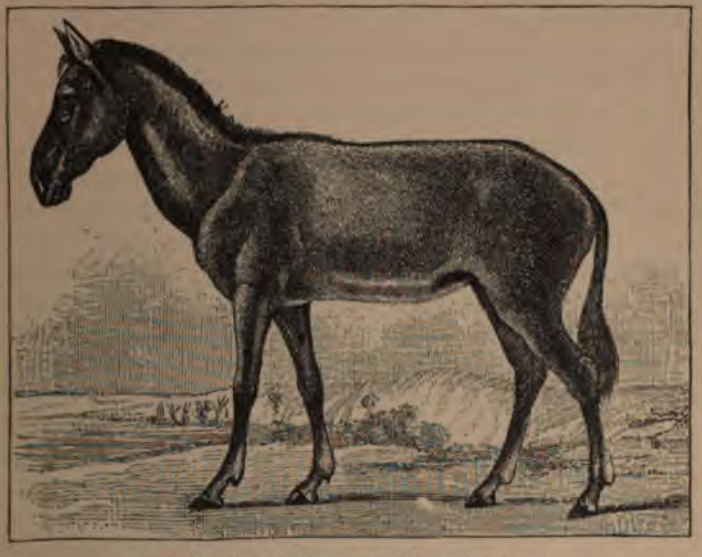

Fig. 2.—Syrian Hemippus (*Equus hemippus*).

of central Europe, that the existing fauna of the Asiatic steppes, which is characterized by the presence of the saïga, the jerboa, and the souslik, extended into Germany and the north of France. Two species of *Equidæ* form a part of this fauna—the hemione (*Equus hemionus*) and the wild horse (*Equus caballus ferus*), which is probably identical with *Equus Prejevalskii*.

The wild horse of Dzungaria is, of all the species of the genus, the one of most northern habitat. This fact explains why the domestic horse supports so well the winters of northern Europe,

* According to Herodotus, there were in his time wild horses in Scythia, on the banks of the Hypanis, which were white, like Prejevalski's horse. The Asiatic tarpans are never of as clear a color.

while the ass is hard to raise in the north of France, and can not live in Sweden. Furthermore, wild horses were still living, in the sixteenth century, in the Vosges Mountains, as was said by Elisée Roesslin, of Haguenau, in a book published at Strasburg in 1593: "Among the animals that are met in the Vosges, first to be noticed, which would be a marvel in many countries, are the wild horses. They keep in the forests and the mountains, providing their own support, and breeding and increasing at all seasons. In winter they hunt for a shelter under the rocks, feeding, like large game, on the brooms, heaths, and branches of trees. They are wilder and more savage than are the deer of many countries, and as hard to capture as they. Men become masters of them, as with the deer, by the aid of the lakes. When they have succeeded in taming and subduing them—a long and difficult task—they have horses of the best quality. These horses withstand the severest cold and are satisfied with the coarsest food. Their walk is sure, their footing firm and solid, because they are accustomed, like the chamois, to run over the mountains and leap the rocks. If the Vosges support wild horses, while the Black Forest has no such animals, they owe the privilege to their northern exposure, their sterility, and the prevalence of fierce north winds." Wild horses existed at the same time in the Swiss Alps and in Prussia (Erasmus Stella, 1518), and their flesh was eaten as in the Quaternary epoch. Unfortunately, no description or picture of these animals is left us; and although Bishop Fortunat speaks of them as onagras, he was most probably speaking of horses that had become wild—the tarpans—and not real wild horses like *Equus Prejevalskii*.

FIG. 3.—FAC-SIMILE OF AN ENGRAVING ON BONE, REPRESENTING A HORSE WITH A BRUSH TAIL AND ERECT MANE. (Cave of Lorthet-Fouilles, by M. Piette.)

The engraving we give of the Prejevalski horse was made from the type of the species in the Museum of the Academy of Sciences of St. Petersburg, and has been obtained from Prof. Eugen Buchner, director of the museum. It is a reproduction of the figure accompanying Poliakoff's memoir in the publications of the Russian Imperial Geographical Society.

We also give, for comparison, the figure (2) of a species of hemione, the Syrian hemippus (*Equus hemippus*), purposely chosen because it is the species most like the horse in its elegant form and the small size of its ears. This picture is an exact copy of a

vellum in the museum, painted from life by M. Bocourt, and represents one of two individuals brought from Damascus in 1855, by M. Bourgoing, which lived for some time at the menagerie of the Paris Museum.—*Translated for the Popular Science Monthly from La Nature.*

THE LIGHTS OF THE CHURCH AND THE LIGHT OF SCIENCE.

By Prof. T. H. HUXLEY, F.R.S.

THERE are three ways of regarding any account of past occurrences, whether delivered to us orally or recorded in writing.

The narrative may be exactly true. That is to say, the words taken in their natural sense, and interpreted according to the rules of grammar, may convey to the mind of the hearer, or of the reader, an idea precisely correspondent with one which would have remained in the mind of a witness. For example, the statement that King Charles I was beheaded at Whitehall on the 30th day of January, 1649, is as exactly true as any proposition in mathematics or physics; no one doubts that any person of sound faculties, properly placed, who was present at Whitehall throughout that day, and who used his eyes, would have seen the king's head cut off; and that there would have remained in his mind an idea of that occurrence which he would have put into words of the same value as those which we use to express it.

Or the narrative may be partly true and partly false. Thus, some histories of the time tell us what the king said, and what Bishop Juxon said; or report royalist conspiracies to effect a rescue; or detail the motives which induced the chiefs of the Commonwealth to resolve that the king should die. One account declares that the king knelt at a high block, another that he lay down with his neck on a mere plank. And there are contemporary pictorial representations of both these modes of procedure. Such narratives, while veracious as to the main event, may and do exhibit various degrees of unconscious and conscious misrepresentation, suppression, and invention, till they become hardly distinguishable from pure fictions. Thus, they present a transition to narratives of a third class, in which the fictitious element predominates. Here, again, there are all imaginable gradations, from such works as Defoe's *quasi*-historical account of the plague year, which probably gives a truer conception of that dreadful time than any authentic history, through the historical novel, drama, and epic, to the purely phantasmal creations of imagina-

tive genius, such as the old Arabian Nights or the modern Shaving of Shagpat. It is not strictly needful for my present purpose that I should say anything about narratives which are professedly fictitious. Yet it may be well, perhaps, if I disclaim any intention of derogating from their value, when I insist upon the paramount necessity of recollecting that there is no sort of relation between the ethical, or the æsthetic, or even the scientific importance of such works, and their worth as historical documents. Unquestionably, to the poetic artist, or even to the student of psychology, Hamlet and Macbeth may be better instructors than all the books of a wilderness of professors of æsthetics or moral philosophy. But, as evidence of occurrences in Denmark, or in Scotland, at the times and places indicated, they are out of court; the profoundest admiration for them, the deepest gratitude for their influence, are consistent with the knowledge that, historically speaking, they are worthless fables, in which any foundation of reality that may exist is submerged beneath the imaginative superstructure.

At present, however, I am not concerned to dwell upon the importance of fictitious literature and the immensity of the work which it has effected in the education of the human race. I propose to deal with the much more limited inquiry, Are there two other classes of consecutive narratives (as distinct from statements of individual facts), or only one? Is there any known historical work which is throughout exactly true, or is there not? In the case of the great majority of histories the answer is not doubtful: they are all only partially true. Even those venerable works which bear the names of some of the greatest of ancient Greek and Roman writers, and which have been accepted by generation after generation, down to modern times, as stores of unquestionable truth, have been compelled by scientific criticism, after a long battle, to descend to the common level, and to confess to a large admixture of error. I might fairly take this for granted; but it may be well that I should intrench myself behind the very apposite words of a historical authority who is certainly not obnoxious to even a suspicion of skeptical tendencies:

> Time was—and that not very long ago—when all the relations of ancient authors concerning the old world were received with a ready belief; and an unreasoning and uncritical faith accepted with equal satisfaction the narrative of the campaigns of Cæsar and of the doings of Romulus, the account of Alexander's marches and of the conquests of Semiramis. We can most of us remember when, in this country, the whole story of regal Rome, and even the legend of the Trojan settlement in Latium, were seriously placed before boys as history and discoursed of as unhesitatingly and in as dogmatic a tone as the tale of the Catiline conspiracy or the conquest of Britain. . . .
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> But all this is now changed. The last century has seen the birth and growth

of a new science—the science of Historical Criticism. . . . The whole world of profane history has been revolutionized. . . .*

If these utterances were true when they fell from the lips of a Bampton lecturer in 1859, with how much greater force do they appeal to us now, when the immense labors of the generation now passing away constitute one vast illustration of the power and fruitfulness of scientific methods of investigation in history, no less than in all other departments of knowledge!

At the present time, I suppose, there is no one who doubts that histories which appertain to any other people than the Jews, and their spiritual progeny in the first century, fall within the second class of the three enumerated. Like Goethe's Autobiography, they might all be entitled Wahrheit und Dichtung—Truth and Fiction. The proportion of the two constituents changes indefinitely; and the quality of the fiction varies through the whole gamut of unveracity. But "Dichtung" is always there. For the most acute and learned of historians can not remedy the imperfections of his sources of information; nor can the most impartial wholly escape the influence of the "personal equation" generated by his temperament and by his education. Therefore, from the narratives of Herodotus to those set forth in yesterday's Times, all history is to be read subject to the warning that fiction has its share therein. The modern vast development of fugitive literature can not be the unmitigated evil that some do vainly say it is, since it has put an end to the popular delusion of less press-ridden times, that what appears in print must be true. We should rather hope that some beneficent influence may create among the erudite a like healthy suspicion of manuscripts and inscriptions, however ancient; for a bulletin may lie, even though it be written in cuneiform characters. Hotspur's starling, that was to be taught to speak nothing but "Mortimer" into the ears of King Henry IV, might be a useful inmate of every historian's library, if "Fiction" were substituted for the name of Harry Percy's friend.

But it was the chief object of the lecturer to the congregation gathered in St. Mary's, Oxford, thirty-one years ago, to prove to them, by evidence gathered with no little labor and marshaled with much skill, that one group of historical works was exempt from the general rule; and that the narratives contained in the canonical Scriptures are free from any admixture of error. With justice and candor, the lecturer impresses upon his hearers that the special distinction of Christianity, among the religions of the world, lies in its claim to be historical; to be surely founded upon

* Bampton Lectures (1859), on The Historical Evidences of the Truth of the Scripture Records stated anew, with Special Reference to the Doubts and Discoveries of Modern Times, by the Rev. G. Rawlinson, M. A., pp. 5, 6.

events which have happened, exactly as they are declared to have happened in its sacred books; which are true, that is, in the sense that the statement about the execution of Charles I is true. Further, it is affirmed that the New Testament presupposes the historical exactness of the Old Testament; that the points of contact of "sacred" and "profane" history are innumerable; and that the demonstration of the falsity of the Hebrew records, especially in regard to those narratives which are assumed to be true in the New Testament, would be fatal to Christian theology.

My utmost ingenuity does not enable me to discover a flaw in the argument thus briefly summarized. I am fairly at a loss to comprehend how any one, for a moment, can doubt that Christian theology must stand or fall with the historical trustworthiness of the Jewish Scriptures. The very conception of the Messiah, or Christ, is inextricably interwoven with Jewish history; the identification of Jesus of Nazareth with that Messiah rests upon the interpretation of passages of the Hebrew Scriptures which have no evidential value unless they possess the historical character assigned to them. If the covenant with Abraham was not made; if circumcision and sacrifices were not ordained by Jahveh; if the "ten words" were not written by God's hand on the stone tables; if Abraham is more or less a mythical hero, such as Theseus; the story of the deluge a fiction; that of the fall a legend; and that of the creation the dream of a seer; if all these definite and detailed narratives of apparently real events have no more value as history than have the stories of the regal period of Rome—what is to be said about the Messianic doctrine, which is so much less clearly enunciated? And what about the authority of the writers of the books of the New Testament, who, on this theory, have not merely accepted flimsy fictions for solid truths, but have built the very foundations of Christian dogma upon legendary quicksands?

But these may be said to be merely the carpings of that carnal reason which the profane call common sense; I hasten, therefore, to bring up the forces of unimpeachable ecclesiastical authority in support of my position. In a sermon preached last December, in St. Paul's Cathedral,* Canon Liddon declares:

> For Christians it will be enough to know that our Lord Jesus Christ set the seal of his infallible sanction on the whole of the Old Testament. He found the Hebrew canon as we have it in our hands to-day, and he treated it as an authority which was above discussion. Nay, more: he went out of his way—if we may reverently speak thus—to sanction not a few portions of it which modern skepticism rejects. When he would warn his hearers against the dangers of spiritual

* The Worth of the Old Testament, a Sermon preached in St. Paul's Cathedral on the Second Sunday in Advent, December. 8, 1889, by H. P. Liddon, D.D., D.C.L., Canon and Chancellor of St. Paul's. Second edition, revised and with a new preface, 1890.

relapse, he bids them remember "Lot's wife."* When he would point out how worldly engagements may blind the soul to a coming judgment, he reminds them how men ate, and drank, and married, and were given in marriage, until the day that Noah entered into the ark, and the flood came and destroyed them all.† If he would put his finger on a fact in past Jewish history which, by its admitted reality, would warrant belief in his own coming resurrection, he points to Jonah's being three days and three nights in the whale's belly (p. 23).‡

The preacher proceeds to brush aside the common—I had almost said vulgar—apologetic pretext that Jesus was using *ad hominem* arguments, or "accommodating" his better knowledge to popular ignorance, as well as to point out the inadmissibility of the other alternative, that he shared the popular ignorance. And to those who hold the latter view sarcasm is dealt out with no niggard hand:

> But they will find it difficult to persuade mankind that, if he could be mistaken on a matter of such strictly religious importance as the value of the sacred literature of his countrymen, he can be safely trusted about anything else. The trustworthiness of the Old Testament is, in fact, inseparable from the trustworthiness of our Lord Jesus Christ; and if we believe that he is the true Light of the world, we shall close our ears against suggestions impairing the credit of those Jewish Scriptures which have received the stamp of his divine authority (p. 25).

Moreover, I learn from the public journals that a brilliant and sharply-cut view of orthodoxy, of like hue and pattern, was only the other day exhibited in that great theological kaleidoscope, the pulpit of St. Mary's, recalling the time so long passed by, when a Bampton lecturer, in the same place, performed the unusual feat of leaving the faith of old-fashioned Christians undisturbed.

Yet many things have happened in the intervening thirty-one years. The Bampton lecturer of 1859 had to grapple only with the infant Hercules of historical criticism; and he is now a full-grown athlete, bearing on his shoulders the spoils of all the lions that have stood in his path. Surely a martyr's courage, as well as a martyr's faith, is needed by any one who, at this time, is prepared to stand by the following plea for the veracity of the Pentateuch:

> Adam, according to the Hebrew original, was for two hundred and forty-three years contemporary with Methuselah, who conversed for a hundred years with Shem. Shem was for fifty years contemporary with Jacob, who probably saw Jochebed, Moses's mother. Thus Moses might, by oral tradition, have obtained the history of Abraham, and even of the deluge, at third hand; and that of the temptation and the fall at fifth hand. . . .
>
> If it be granted—as it seems to be—that the great and stirring events in a nation's life will, under ordinary circumstances, be remembered (apart from all written memorials) for the space of one hundred and fifty years, being handed down through five generations, it must be allowed (even on mere human grounds)

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* St. Luke, xvii, 32. † Ibid., 27. ‡ St. Matt. xii, 40.

that the account which Moses gives of the temptation and the fall is to be depended upon, if it passed through no more than four hands between him and Adam.*

If "the trustworthiness of our Lord Jesus Christ" is to stand or fall with the belief in the sudden transmutation of the chemical components of a woman's body into sodium chloride, or on the "admitted reality" of Jonah's ejection, safe and sound, on the shores of the Levant, after three days' sea-journey in the stomach of a gigantic marine animal, what possible pretext can there be for even hinting a doubt as to the precise truth of the longevity attributed to the patriarchs? Who that has swallowed the camel of Jonah's journey will be guilty of the affectation of straining at such a historical gnat—nay, midge—as the supposition that the mother of Moses was told the story of the flood by Jacob; who had it straight from Shem; who was on friendly terms with Methuselah; who knew Adam quite well?

Yet, by the strange irony of things, the illustrious brother of the divine who propounded this remarkable theory has been the guide and foremost worker of that band of investigators of the records of Assyria and of Babylonia who have opened to our view, not merely a new chapter, but a new volume of primeval history, relating to the very people who have the most numerous points of contact with the life of the ancient Hebrews. Now, whatever imperfections may yet obscure the full value of the Mesopotamian records, everything that has been clearly ascertained tends to the conclusion that the assignment of no more than four thousand years to the period between the time of the origin of mankind and that of Augustus Cæsar is wholly inadmissible. Therefore, that biblical chronology, which Canon Rawlinson trusted so implicitly in 1859, is relegated by all serious critics to the domain of fable.

But if scientific method, operating in the region of history, of philology, of archæology, in the course of the last thirty or forty years, has become thus formidable to the theological dogmatist, what may not be said about scientific method working in the province of physical science? For, if it be true that the canonical Scriptures have innumerable points of contact with civil history, it is no less true that they have almost as many with natural history; and their accuracy is put to the test as severely by the latter as by the former. The origin of the present state of the heavens and the earth is a problem which lies strictly within the province of physical science; so is that of the origin of man among living things; so is that of the physical changes which the earth has undergone since the origin of man; so is that of the origin of the various races and nations of men, with all their varieties of lan-

* Bampton Lectures, 1859, pp. 50, 51.

guage and physical conformation. Whether the earth moves round the sun or the contrary; whether the bodily and mental diseases of men and animals are caused by evil spirits or not; whether there is such an agency as witchcraft or not—all these are purely scientific questions; and to all of them the canonical Scriptures profess to give true answers. And though nothing is more common than the assumption* that these books come into conflict only with the speculative part of modern physical science, no assumption can have less foundation.

The antagonism between natural knowledge and the Pentateuch would be as great if the speculations of our time had never been heard of. It arises out of contradiction upon matters of fact. The books of ecclesiastical authority declare that certain events happened in a certain fashion; the books of scientific authority say they did not. As it seems that this unquestionable truth has not yet penetrated among many of those who speak and write on these subjects, it may be useful to give a full illustration of it. And for that purpose I propose to deal, at some length, with the narrative of the Noachian Deluge given in Genesis.

The Bampton lecturer, in 1859, and the Canon of St. Paul's, in 1890, are in full agreement that this history is true, in the sense in which I have defined historical truth. The former is of opinion that the account attributed to Berosus records a tradition—

> not drawn from the Hebrew record, much less the foundation of that record; yet coinciding with it in the most remarkable way. The Babylonian version is tricked out with a few extravagances, as the monstrous size of the vessel and the translation of Xisuthros; but otherwise it is the Hebrew history *down to its minutiæ* (p. 64).

Moreover, correcting Niebuhr, the Bampton lecturer points out that the narrative of Berosus distinctly implies the universality of the flood:

> It is plain that the waters are represented as prevailing above the tops of the loftiest mountains in Armenia—a height which must have been seen to involve the submersion of all the countries with which the Babylonians were acquainted (p. 66).

I may remark, in passing, that many people think the size of Noah's ark "monstrous," considering the probable state of the art of ship-building only sixteen hundred years after the origin of man; while others are so unreasonable as to inquire why the translation of Enoch is less an extravagance than that of Xisuthros. It is more important, however, to note that the universality of the deluge is recognized, not merely as a part of the

* For example, it appears to me to pervade and vitiate Mr. Wilfrid Ward's argument in the last number of this review.

story, but as a necessary consequence of some of its details. The latest exponent of Anglican orthodoxy, as we have seen, insists upon the accuracy of the Pentateuchal history of the flood in a still more forcible manner. It is cited as one of those very narratives to which the authority of the Founder of Christianity is pledged, and upon the accuracy of which "the trustworthiness of our Lord Jesus Christ" is staked, just as others have staked it upon the truth of the histories of demoniac possession in the Gospels.

Now, when those who put their trust in scientific methods of ascertaining the truth in the province of natural history find themselves confronted and opposed on their own ground by ecclesiastical pretensions to better knowledge, it is, undoubtedly, most desirable for them to make sure that their conclusions, whatever they may be, are well founded. And, if they put aside the unauthorized interference with their business and relegate the Pentateuchal history to the region of pure fiction, they are bound to assure themselves that they do so because the plainest teachings of nature (apart from all doubtful speculations) are irreconcilable with the assertions which they reject.

At the present time it is difficult to persuade serious scientific inquirers to occupy themselves, in any way, with the Noachian Deluge. They look at you with a smile and a shrug, and say they have more important matters to attend to than mere antiquarianism. But it was not so in my youth. At that time, geologists and biologists could hardly follow to the end any path of inquiry without finding the way blocked by Noah and his ark, or by the first chapter of Genesis; and it was a serious matter, in this country at any rate, for a man to be suspected of doubting the literal truth of the diluvial or any other Pentateuchal history. The fiftieth anniversary of the foundation of the Geological Club in 1825 was, if I remember rightly, the last occasion on which the late Sir Charles Lyell spoke to even so small a public as the members of that body. Our veteran leader lighted up once more, and, referring to the difficulties which beset his early efforts to create a rational science of geology, spoke with his wonted clearness and vigor of the social ostracism which pursued him after the publication of the Principles of Geology, in 1830, on account of the obvious tendency of that noble work to discredit the Pentateuchal accounts of the creation and the deluge. If my younger contemporaries find this hard to believe, I may refer them to a grave book, On the Doctrine of the Deluge, published eight years later, and dedicated by its author to his father, the then Archbishop of York. The first chapter refers to the treatment of the Mosaic Deluge, by Dr. Buckland and Mr. Lyell, in the following terms:

Their respect for revealed religion has prevented them from arraying themselves openly against the scriptural account of it—much less do they deny its truth—but they are in a great hurry to escape from the consideration of it, and evidently concur in the opinion of Linnæus, that no proofs whatever of the deluge are to be discovered in the structure of the earth (p. 1).

And after an attempt to reply to some of Lyell's arguments, which it would be cruel to reproduce, the writer continues:

When, therefore, upon such slender grounds, it is determined, in answer to those who insist upon its universality, that the Mosaic Deluge must be considered a preternatural event, far beyond the reach of philosophical inquiry; not only as to the causes employed to produce it, but also as to the effects most likely to result from it; that determination wears an aspect of skepticism, which, however much soever it may be unintentional in the mind of the writer, yet can not but produce an evil impression on those who are already predisposed to carp and cavil at the evidences of revelation (pp. 8, 9).

The kindly and courteous writer of these curious passages is evidently unwilling to make the geologists the victims of general opprobrium by pressing the obvious consequences of their teaching home. One is, therefore, pained to think of the feelings with which, if he lived so long as to become acquainted with the Dictionary of the Bible, he must have perused the article Noah, written by a dignitary of the Church for that standard compendium and published in 1863. For the doctrine of the universality of the deluge is therein altogether given up; and I permit myself to hope that a long criticism of the story from the point of view of natural science, with which, at the request of the learned theologian who wrote it, I supplied him, may have in some degree contributed toward this happy result.

Notwithstanding diligent search, I have been unable to discover that the universality of the deluge has any defender left, at least among those who have so far mastered the rudiments of natural knowledge as to be able to appreciate the weight of evidence against it. For example, when I turned to the Speaker's Bible, published under the sanction of high Anglican authority, I found the following judicial and judicious deliverance, the skillful wording of which may adorn, but does not hide, the completeness of the surrender of the old teaching:

Without pronouncing too hastily on any fair inferences from the words of Scripture, we may reasonably say that their most natural interpretation is that the whole race of man had become grievously corrupted since the faithful had intermingled with the ungodly; that the inhabited world was consequently filled with violence, and that God had decreed to destroy all mankind except one single family; that, therefore, all that portion of the earth, perhaps as yet a very small portion, into which mankind had spread was overwhelmed by water. The ark was ordained to save one faithful family; and lest that family, on the subsidence of the waters, should find the whole country round them a desert, a pair of all the

beasts of the land and of the fowls of the air were preserved along with them, and along with them went forth to replenish the now desolated continent. The words of Scripture (confirmed as they are by universal tradition) appear at least to mean as much as this. They do not necessarily mean more.*

In the third edition of Kitto's Cyclopædia of Bibical Literature (1876), the article Deluge, written by my friend the present distinguished head of the Geological Survey of Great Britain, extinguishes the universality doctrine as thoroughly as might be expected from its authorship; and, since the writer of the article Noah refers his readers to that entitled Deluge, it is to be supposed, notwithstanding his generally orthodox tone, that he does not dissent from its conclusions. Again, the writers in Herzog's Real-Encyclopädie (Bd. X, 1882) and in Riehm's Handwörterbuch (1884)—both works with a conservative leaning—are on the same side; and Diestel,† in his full discussion of the subject, remorselessly rejects the universality doctrine. Even that stanch opponent of scientific rationalism—may I say rationality?—Zöckler,‡ flinches from a distinct defense of the thesis, any opposition to which, well within my recollection, was howled down by the orthodox as mere "infidelity." All that, in his sore straits, Dr. Zöckler is able to do, is to pronounce a faint commendation upon a particularly absurd attempt at reconciliation, which would make out the Noachian Deluge to be a catastrophe which occurred at the end of the Glacial epoch. This hypothesis involves only the trifle of a physical revolution of which geology knows nothing; and which, if it secured the accuracy of the Pentateuchal writer about the fact of the deluge, would leave the details of his account as irreconciliable with the truths of elementary physical science as ever. Thus I may be permitted to spare myself and my readers the weariness of a recapitulation of the overwhelming arguments against the universality of the deluge, which they will now find for themselves stated, as fully and forcibly as could be wished, by Anglican and other theologians, whose orthodoxy and conservative tendencies have, hitherto, been above suspicion. Yet many fully admit (and, indeed, nothing can be plainer) that the Pentateuchal narrator means to convey that, as a matter of fact, the whole earth known to him was inundated; nor is it less obvious that unless all mankind, with the exception of Noah and his family, were actually destroyed, the references to the flood in the New Testament are unintelligible.

But I am quite aware that the strength of the demonstration that no universal deluge ever took place has produced a change of front in the army of apologetic writers. They have imagined that

* Commentary on Genesis, by the Bishop of Ely, p. 77.

† Die Sintflut, 1876.

‡ Theologie und Naturwissenschaft, ii, 784–791 (1877).

the substitution of the adjective partial for universal will save the credit of the Pentateuch, and permit them, after all, without too many blushes, to declare that the progress of modern science only strengthens the authority of Moses. Nowhere have I found the case of the advocates of this method of escaping from the difficulties of the actual position better put than in the lecture of Prof. Diestel to which I have referred. After frankly admitting that the old doctrine of universality involves physical impossibilities, he continues:

> All these difficulties fall away as soon as we give up the universality of the deluge, and imagine a *partial* flooding of the earth, say in western Asia. But have we a right to do so? The narrative speaks of "the whole earth." But what is the meaning of this expression? Surely not the whole surface of the earth according to the ideas of *modern* geographers, but, at most, according to the conceptions of the biblical author. This very simple conclusion, however, is never drawn by too many readers of the Bible. But one need only cast one's eyes over the tenth chapter of Genesis in order to become acquainted with the geographical horizon of the Jews. In the north it was bounded by the Black Sea and the mountains of Armenia; extended toward the east very little beyond the Tigris; hardly reached the apex of the Persian Gulf; passed, then, through the middle of Arabia and the Red Sea; went southward through Abyssinia, and then turned westward by the frontiers of Egypt, and inclosed the easternmost islands of the Mediterranean (p. 11).

The justice of this observation must be admitted, no less than the further remark that, in still earlier times, the pastoral Hebrews very probably had yet more restricted notions of what constituted "the whole earth." Moreover, I, for one, fully agree with Prof. Diestel that the motive, or generative incident, of the whole story is to be sought in the occasionally excessive and desolating floods of the Euphrates and Tigris.

Let us, provisionally, accept the theory of a partial deluge, and try to form a clear mental picture of the occurrence. Let us suppose that, for forty days and forty nights, such a vast quantity of water was poured upon the ground that the whole surface of Mesopotamia was covered by water to a depth certainly greater, probably much greater, than fifteen cubits, or twenty feet (Gen. vii, 20). The inundation prevails upon the earth for one hundred and fifty days; and then the flood gradually decreases, until, on the seventeenth day of the seventh month the ark, which had previously floated on its surface, grounds upon the "mountains of Ararat"* (Gen. viii, 34). Then, as Diestel has acutely pointed out (Sintflut, p. 13), we are to imagine the further subsidence of the flood to take place so gradually that it was not until nearly two months and a half after this time (that is to say,

* It is very doubtful if this means the region of the Armenian Ararat. More probably it designates some part, either of the Kurdish range or of its southeastern continuation.

on the first day of the tenth month) that the "tops of the mountains" became visible. Hence it follows that, if the ark drew even as much as twenty feet of water, the level of the inundation fell very slowly—at a rate of only a few inches a day—until the top of the mountain on which it rested became visible. This is an amount of movement which, if it took place in the sea, would be overlooked by ordinary people on the shore. But the Mesopotamian plain slopes gently, from an elevation of five hundred or six hundred feet at its northern end, to the sea, at its southern end, with hardly so much as a notable ridge to break its uniform flatness, for three hundred to four hundred miles. These being the conditions of the case, the following inquiry naturally presents itself: not, be it observed, as a recondite problem, generated by modern speculation, but as a plain suggestion flowing out of that very ordinary and archaic piece of knowledge that water can not be piled up in a heap like sand; or that it seeks the lowest level. When, after one hundred and fifty days, "the fountains also of the deep and the windows of heaven were stopped, and the rain from heaven was restrained" (Gen. viii, 2), what prevented the mass of water, several, possibly very many, fathoms deep, which covered, say, the present site of Bagdad, from sweeping seaward in a furious torrent; and, in a very few hours, leaving, not only the "tops of the mountains," but the whole plain, save any minor depressions, bare? How could its subsidence, by any possibility, be an affair of weeks and months?

And if this difficulty is not enough, let any one try to imagine how a mass of water several, perhaps very many, fathoms deep, could be accumulated on a flat surface of land rising well above the sea, and separated from it by no sort of barrier. Most people know Lord's Cricket-ground. Would it not be in absurd contradiction to our common knowledge of the properties of water to imagine that, if all the mains of all the water-works of London were turned on to it, they could maintain a heap of water twenty feet deep over its level surface? Is it not obvious that the water, whatever momentary accumulation might take place at first, would not stop there, but that it would dash, like a mighty mill-race, southward down the gentle slope which ends in the Thames? And is it not further obvious, that whatever depth of water might be maintained over the cricket-ground, so long as all the mains poured on to it, anything which floated there would be speedily whirled away by the current, like a cork in a gutter when the rain pours? But if this is so, then it is no less certain that Noah's deeply laden, sailless, oarless, and rudderless craft, if by good fortune it escaped capsizing in whirlpools, or having its bottom knocked into holes by snags (like those which prove fatal even to well-built steamers on the Mississippi in our day), would have

speedily found itself a good way down the Persian Gulf, and not long after in the Indian Ocean, somewhere between Arabia and Hindostan. Even if, eventually, the ark might have gone ashore, with other jetsam and flotsam, on the coasts of Arabia, or of Hindostan, or of the Maldives, or of Madagascar, its return to the "mountains of Ararat" would have been a miracle more stupendous than all the rest.

Thus, the last state of the would-be reconcilers of the story of the deluge with fact is worse than the first. All that they have done is to transfer the contradictions to established truth from the region of science proper to that of common information and common sense. For, really, the assertion that the surface of a body of deep water, to which no addition was made, and which there was nothing to stop from running into the sea, sank at the rate of only a few inches or even feet a day, simply outrages the most ordinary and familiar teachings of every man's daily experience. A child may see the folly of it.

In addition, I may remark that the necessary assumption of the "partial deluge" hypothesis (if it is confined to Mesopotamia) that the Hebrew writer must have meant low hills when he said "high mountains"—is quite untenable. On the eastern side of the Mesopotamian plain, the snowy peaks of the frontier ranges of Persia are visible from Bagdad,* and even the most ignorant herdsmen in the neighborhood of "Ur of the Chaldees," near its western limit, could hardly have been unacquainted with the comparatively elevated plateau of the Syrian Desert which lay close at hand. But, surely, we must suppose the biblical writer to be acquainted with the highlands of Palestine and with the masses of the Sinaitic Peninsula, which soar more than eight thousand feet above the sea, if he knew of no higher elevations; and, if so, he could not well have meant to refer to mere hillocks when he said that "all the high mountains which were under the whole heaven were covered" (Gen. vii, 19). Even the hill-country of Galilee reaches an elevation of four thousand feet; and a flood which covered it could by no possibility have been other than universal in its superficial extent. Water really can not be got to stand at, say, four thousand feet above the sea-level over Palestine, without covering the rest of the globe to the same height. Even if in the course of Noah's six hundredth year some prodigious convulsion had sunk the whole region inclosed within "the horizon of the geographical knowledge" of the Israelites by that much, and another had pushed it up again, just in time to catch the ark upon "the mountains of Ararat," matters are not much

* So Reclus (Nouvelle Géographie Universelle, ix, 386), but I find the statement doubted by an authority of the first rank.

mended. I am afraid to think of what would have become of a vessel so little seaworthy as the ark and of its very numerous passengers, under the peculiar obstacles to quiet flotation which such rapid movements of depression and upheaval would have generated.

Thus, in view, not, I repeat, of the recondite speculations of infidel philosophers, but in the face of the plainest and most commonplace of ascertained physical facts, the story of the Noachian Deluge has no more claim to credit than has that of Deucalion; and, whether it was or was not suggested by the familiar acquaintance of its originators with the effects of unusually great overflows of the Tigris and Euphrates, it is utterly devoid of historical truth.

That is, in my judgment, the necessary result of the application of criticism, based upon assured physical knowledge, to the story of the deluge. And it is satisfactory that the criticism which is based, not upon literary and historical speculation, but on well-ascertained facts in the departments of literature and of history, tends to exactly the same conclusion.

For I find this much agreed upon by all biblical scholars of repute, that the story of the deluge in Genesis is separable into at least two sets of statements; and that, when the statements thus separated are recombined in their proper order, each set furnishes an account of the event, coherent and complete within itself, but in some respects discordant with that afforded by the other set. This fact, as I understand, is not disputed. Whether one of these is the work of an Elohist and the other of a Jehovist narrator; whether the two have been pieced together in this strange fashion because, in the estimation of the compilers and editors of the Pentateuch, they had equal and independent authority, or not; or whether there is some other way of accounting for it, are questions the answer to which do not affect the fact. If possible, I avoid *a priori* arguments. But still, I think it may be urged, without imprudence, that a narrative having this structure is hardly such as might be expected from a writer possessed of full and infallibly accurate knowledge. Once more, it would seem that it is not necessarily the mere inclination of the skeptical spirit to question everything, or the willful blindness of infidels, which prompts grave doubts as to the value of a narrative thus curiously unlike the ordinary run of veracious histories.

But the voice of archæological and historical criticism still has to be heard; and it gives forth no uncertain sound. The marvelous recovery of the records of an antiquity, far superior to any that can be ascribed to the Pentateuch, which has been effected by the decipherers of cuneiform characters, has put us in posses-

sion of a series, once more, not of speculations, but of facts, which have a most remarkable bearing upon the question of the trustworthiness of the narrative of the flood. It is established that, for centuries before the asserted migration of Terah from Ur of the Chaldees (which, according to the orthodox interpreters of the Pentateuch, took place after the year 2000 B. C.), lower Mesopotamia was the seat of a civilization in which art and science and literature had attained a development formerly unsuspected, or, if there were faint reports of it, treated as fabulous. And it is also no matter of speculation, but a fact, that the libraries of these people contain versions of a long epic poem, one of the twelve books of which tells a story of a deluge which, in a number of its leading features, corresponds with the story attributed to Berosus, no less than with the story given in Genesis, with curious exactness. Thus, the correctness of Canon Rawlinson's conclusion, cited above, that the story of Berosus was neither drawn from the Hebrew record, nor is the foundation of it, can hardly be questioned. It is highly probable, if not certain, that Berosus relied upon one of the versions (for there seem to have been several) of the old Babylonian epos, extant in his time; and if that is a reasonable conclusion, why is it unreasonable to believe that the two stories, which the Hebrew compiler has put together in such inartistic fashion, were ultimately derived from the same source? I say ultimately, because it does not at all follow that the two versions, possibly trimmed by the Jehovistic writer on the one hand, and by the Elohistic on the other, to suit Hebrew requirements, may not have been current among the Israelites for ages. And they may have acquired great authority before they were combined in the Pentateuch.

Looking at the convergence of all these lines of evidence to the one conclusion—that the story of the flood in Genesis is merely a Bowdlerized version of one of the oldest pieces of purely fictitious literature extant; that whether this is or is not its origin, the events asserted in it to have taken place assuredly never did take place; further, that, in point of fact, the story, in the plain and logically necessary sense of its words, has long since been given up by orthodox and conservative commentators of the Established Church—I can but admire the courage and clear foresight of the Anglican divine who tells us that we must be prepared to choose between the trustworthiness of scientific method and the trustworthiness of that which the Church declares to be divine authority. For, to my mind, this declaration of war to the knife against secular science, even in its most elementary forms; this rejection without a moment's hesitation of any and all evidence which conflicts with theological dogma, is the only position which is logically reconcilable with the axioms of orthodoxy. If the

Gospels truly report that which an incarnation of the God of Truth communicated to the world, then it surely is absurd to attend to any other evidence touching matters about which he made any clear statement, or the truth of which is distinctly implied by his words. If the exact historical truth of the gospel is an axiom of Christianity, it is as just and right for a Christian to say, Let us "close our ears against suggestions" of scientific critics, as it is for the man of science to refuse to waste his time upon circle-squarers and flat-earth fanatics.

It is commonly reported that the manifesto by which the Canon of St. Paul's proclaims that he nails the colors of the straitest biblical infallibility to the mast of the ship ecclesiastical, was put forth as a counterblast to Lux Mundi; and that the passages which I have more particularly quoted are directed against the essay on The Holy Spirit and Inspiration in that collection of treatises by Anglican divines of high standing, who must assuredly be acquitted of conscious "infidel" proclivities. I fancy that rumor must, for once, be right, for it is impossible to imagine a more direct and diametrical contradiction than that between the passages from the sermon cited above and those which follow:

> What is questioned is that our Lord's words foreclose certain critical positions as to the character of Old Testament literature. For example, does his use of Jonah's resurrection as a *type* of his own, depend in any real degree upon whether it is historical fact or allegory? . . . Once more, our Lord uses the time before the flood, to illustrate the carelessness of men before his own coming. . . . In referring to the flood he certainly suggests that he is treating it as typical, for he introduces circumstances—"eating and drinking, marrying and giving in marriage"—which have no counterpart in the original narrative (pp. 358, 359).

While insisting on the flow of inspiration through the whole of the Old Testament, the essayist does not admit its universality. Here, also, the new apologetic demands a partial flood:

> But does the inspiration of the recorder guarantee the exact historical truth of what he records? And, in matter of fact, can the record, with due regard to legitimate historical criticism, be pronounced true? Now, to the latter of these two questions (and they are quite distinct questions) we may reply that there is nothing to prevent our believing, as our faith strongly disposes us to believe, that the record from Abraham downward is, in substance, in the strict sense historical (p. 351).

It would appear, therefore, that there is nothing to prevent our believing that the record, from Abraham upward, consists of stories in the strict sense unhistorical, and that the pre-Abrahamic narratives are mere moral and religious "types" and parables.

I confess I soon lose my way when I try to follow those who

walk delicately among "types" and allegories. A certain passion for clearness forces me to ask, bluntly, whether the writer means to say that Jesus did not believe the stories in question, or that he did? When Jesus spoke, as of a matter of fact, that "the flood came and destroyed them all," did he believe that the deluge really took place, or not? It seems to me that, as the narrative mentions Noah's wife, and his sons' wives, there is good scriptural warranty for the statement that the antediluvians married and were given in marriage; and I should have thought that their eating and drinking might be assumed by the firmest believer in the literal truth of the story. Moreover, I venture to ask what sort of value, as an illustration of God's methods of dealing with sin, has an account of an event that has never happened? If no flood swept the careless people away, how is the warning of more worth than the cry of "wolf" when there is no wolf? If Jonah's three days' residence in the whale is not an "admitted reality," how could it "warrant belief" in the "coming resurrection"? If Lot's wife was not turned into a pillar of salt, the bidding those who turn back from the narrow path to "remember" it is, morally, about on a level with telling a naughty child that a bogy is coming to fetch it away. Suppose that a conservative orator warns his hearers to beware of great political and social changes, lest they end, as in France, in the domination of a Robespierre; what becomes, not only of his argument, but of his veracity, if he, personally, does not believe that Robespierre existed and did the deeds attributed to him?

Like all other attempts to reconcile the results of scientifically conducted investigation with the demands of the outworn creeds of ecclesiasticism, the essay on Inspiration is just such a failure as must await mediation, when the mediator is unable properly to appreciate the weight of the evidence for the case of one of the two parties. The question of "inspiration" really possesses no interest for those who have cast ecclesiasticism and all its works aside, and have no faith in any source of truth save that which is reached by the patient application of scientific methods. Theories of inspiration are speculations as to the means by which the authors of statements, in the Bible or elsewhere, have been led to say what they have said—and it assumes that natural agencies are insufficient for the purpose. I prefer to stop short of this problem, finding it more profitable to undertake the inquiry which naturally precedes it—namely, Are these statements true or false? If they are true, it may be worth while to go into the question of their supernatural generation; if they are false, it certainly is not worth mine.

Now, not only do I hold it to be proved that the story of the deluge is a pure fiction; but I have no hesitation in affirming the

same thing of the story of the creation.* Between these two lies the story of the creation of man and woman and their fall from primitive innocence, which is even more monstrously improbable than either of the other two, though, from the nature of the case, it is not so easily capable of direct refutation. It can be demonstrated that the earth took longer than six days in the making, and that the deluge, as described, is a physical impossibility; but there is no proving, especially to those who are perfect in the art of closing their ears to that which they do not wish to hear, that a snake did not speak, or that Eve was not made out of one of Adam's ribs.

The compiler of Genesis, in its present form, evidently had a definite plan in his mind. His countrymen, like all other men, were doubtless curious to know how the world began; how men, and especially wicked men, came into being, and how existing nations and races rose among the descendants of one stock; and, finally, what was the history of their own particular tribe. They, like ourselves, desired to solve the four great problems of cosmogeny, anthropogeny, ethnogeny, and geneogeny. The Pentateuch furnishes the solutions which appeared satisfactory to its author. One of these, as we have seen, was borrowed from a Babylonian fable; and I know of no reason to suspect any different origin from the rest. Now, I would ask, is the story of the fabrication of Eve to be regarded as one of those pre-Abrahamic narratives, the historical truth of which is an open question, in face of the reference to it in a speech unhappily famous for the legal oppression to which it has been wrongfully forced to lend itself?

> Have ye not read, that he which made them from the beginning made them male and female, and said, For this cause shall a man leave his father and mother, and cleave to his wife; and the twain shall become one flesh? (Matthew, xix, 5).

If divine authority is not here claimed for the twenty-fourth verse of the second chapter of Genesis, what is the value of language? And again, I ask, if one may play fast and loose with the story of the fall, as a "type" or "allegory," what becomes of the foundation of Pauline theology?—

> For since by man came death, by man came also the resurrection of the dead.

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* So far as I know, the narrative of the creation is not now held to be true, in the sense in which I have defined historical truth, by any of the reconcilers. As for the attempts to stretch the Pentateuchal days into periods of thousands or millions of years, the verdict of the eminent biblical scholar, Dr. Richm (Der biblische Schöpfungsbericht, 1881, pp. 15, 16), on such pranks of "Auslegungskunst" should be final. Why do the reconcilers take Goethe's advice seriously?—

> "Im Auslegen seyd frisch und munter!
> Legt ihr's nicht aus, so legt was unter."

For as in Adam all die, so also in Christ shall all be made alive (1 Corinthians, xv, 21, 22).

If Adam may be held to be no more real a personage than Prometheus, and if the story of the fall is merely an instructive "type," comparable to the profound Promethean mythus, what value has Paul's dialectic?

While, therefore, every right-minded man must sympathize with the efforts of those theologians who have not been able altogether to close their ears to the still, small voice of reason, to escape from the fetters which ecclesiasticism has forged, the melancholy fact remains, that the position they have taken up is hopelessly untenable. It is raked alike by the old-fashioned artillery of the churches and by the fatal weapons of precision with which the *enfants perdus* of the advancing forces of science are armed. They must surrender, or fall back into a more sheltered position. And it is possible that they may long find safety in such retreat.

It is, indeed, probable that the proportional number of those who will distinctly profess their belief in the transubstantiation of Lot's wife, and the anticipatory experience of submarine navigation by Jonah; in water standing fathoms deep on the side of a declivity without anything to hold it up; and in devils who enter swine, will not increase. But neither is there ground for much hope that the proportion of those who cast aside these fictions and adopt the consequence of that repudiation, are, for some generations, likely to constitute a majority. Our age is a day of compromises. The present and the near future seem given over to those happily, if curiously, constituted people who see as little difficulty in throwing aside any amount of post-Abrahamic scriptural narrative, as the authors of Lux Mundi see in sacrificing the pre-Abrahamic stories; and, having distilled away every inconvenient matter of fact in Christian history, continue to pay divine honors to the residue. There really seems to be no reason why the next generation should not listen to a Bampton lecture modeled upon that addressed to the last:

Time was—and that not very long ago—when all the relations of biblical authors concerning the old world were received with a ready belief; and an unreasoning and uncritical faith accepted with equal satisfaction the narrative of the captivity and the doings of Moses at the court of Pharaoh, the account of the apostolic meeting in the Epistle to the Galatians, and of the fabrication of Eve. We can most of us remember when, in this country, the whole story of the Exodus, and even the legend of Jonah, were seriously placed before boys as history, and discoursed of in as dogmatic a tone as the tale of Agincourt or the history of the Norman Conquest.

But all this is now changed. The last century has seen the growth of scientific criticism to its full length. The whole world of history has been revolution-

lized, and the mythology which embarrassed earnest Christians has vanished as an evil mist, the lifting of which has only more fully revealed the lineaments of infallible truth. No longer in contact with fact of any kind, faith stands now and forever proudly inaccessible to the attacks of the infidel.

So far the apologist of the future. Why not? *Cantabit vacuus.—Nineteenth Century.*

A LITTLE BOYS' GAME WITH A BALL.

By HENRY J. PHILPOTT.

A YEAR or two ago there went the rounds of the daily papers a few verses intended to express the feelings of an elderly lady from the country when her city folks had taken her to see the national game. It was all very interesting and funny, but may be summed up in her oftenest-repeated couplet:

"Jist a passel o' big men a-playin'
A little boys' game with a ball"—

which was a true bill. But how came these men to be playing this little boys' game? Here steps in the student of sociology, and offers explanations in abundance. The truly great philosopher of this and all generations is the man who for the first time considers unconsidered trifles. Herein lies the greatness of Herbert Spencer.

In this matter we all have a duty which most of us are likely to forget. We should record for the benefit of the coming philosopher, who by the process of evolution is sure to have a finer and more effective brain than ours, certain facts which seem trivial to us, but which may be of transcendent importance to him. What if our predecessors had scrupulously done likewise? How much more satisfactory would have been our nineteenth-century philosophy!

Hit or miss, I propose to describe a few of the ball-plays I learned as pupil and teacher in country schools within twenty miles of the Mississippi River, and about half-way between St. Louis and St. Paul. I shall not be deterred by the reflection that others may be able, if they would, to describe a greater variety of ball-games.

Did you ever stop to think how much of human life there is consumed in games of ball? A marble is a ball. So is a billiard-ball, a croquet-ball. So—did you ever think of it?—are shot and shell, though their elongation in modern military engineering has made war less truly than it used to be

"Jist a passel o' big men a-playin'
A little boys' game with a ball."

Perhaps the first thing that boys in their games ever did with a ball was to hit other boys with it. At any rate, their games in my time have been made of such simple elements as the effort to—

1. Hit somebody. 2. Hit a target. 3. Hit another ball, as in marbles. 4. Catch the ball. 5. Bat the ball. 6. Run to a goal, or out of reach of the ball, before being hit or "crossed out." And, of course— 7. Prevent the enemy from accomplishing any of these things.

Ball-games are products, and pretty good illustrations, of the process of evolution. Hence it is fitting to proceed in their discussion as Nature proceeds in evolution—from the simple to the complex. We can beat Haeckel at this. He can not bridge the gap between life and not-life, but we can go back of all ball-games to a primordial ball-playing which is not a game at all. When a number of boys engage in indiscriminately hitting one another, they often enjoy the excitement, but they are not playing a game. They begin to play a game when they introduce forfeits, or rewards, or both.

The commonest forfeit is that of the right to play—that is, the player who misses is "out" for the remainder of the game or inning. The moment this was introduced, what was called "sock-ball" became a real game. There were no bases, no bats, no anything except a lot of boys, and a ball with which they were trying to hit one another. But if one threw and missed, or his ball was caught, he was out. When all but one, or an agreed number, were out, the game was ended, and a new one was started. Of course, the last boy could not be put out, for there were no players for him to throw at and miss. He won the game, and his reward was the first throw on the new game.

The game of "hole-ball," or "wibble-wobble," retained these features, and added a hole in the ground large enough to nicely hold the ball. The reward of the winner was not the first throw, but the privilege of placing the ball in the hole and naming the first thrower, who had the advantage of a throw before the players had time to scatter—for, of course, they all stood close by the hole until the name was called, each thinking it might be his own. It required considerable alertness to be ready to instantly do either one of two things—seize and throw the ball, or run away. Faculties were called into exercise which, if duly cultivated, help to make success all through life. They are the faculties needed by the general, who may at any moment be forced to fight or forced to retreat. As the game proceeds, the players come back to the hole every time one goes out on a miss or a catch, and the one who is missed or catches the ball puts it in the hole and names the next thrower, and so on until all but one are out. The hole serves constantly as a base of operations, and the player who at

any time is hit, and must therefore try to hit a fellow, may throw from where he finds the ball on the ground, or from any point between there and the hole. That was our rule, at any rate.

The hole was sometimes replaced by the boys' hats, and the owner of the hat into which the ball was dropped was the next thrower. This was called "hat-ball." A new feature was sometimes introduced. A single miss did not put the player out. For each miss he put a chip or pebble into his hat for a counter, called a "pig." When he had accumulated an agreed number of pigs, he was out.

Retaining all these features except the hats, the game of "roll-a-hole" went back to the hole in the ground; but, instead of a single one, there was a row of them—as many as there were players. The ball was rolled along the line of these holes, and would stop in one of them. Thus the thrower was chosen by lot, and not by discrimination; though, of course, this was not always true if the ball-holder was dishonest, and had any desire to discriminate. He was closely watched, and often accused of unfairness. It is ever thus.

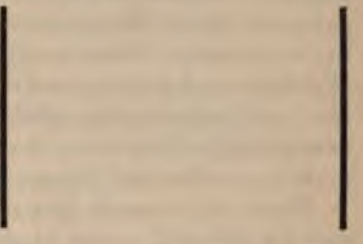
I do not recall any other games of this class that we played. The most popular of them was the one called "wibble-wobble" in our school, and "hole-ball" wherever else I have seen it. Hat-ball and roll-a-hole may be higher forms, the latter seeming to me to be the last of its line.

There is an allied line of games which reached a more interesting development. The simplest form of it that I have seen was called "draw-base" by the boy who brought its traditions to our school. Here for the first time the players were divided into two opposing teams, and bases were introduced. These bases were two, facing each other, and the ball was thrown from one base to the other in the effort to hit one of the opposing players, all of whom were standing on the bases. A player who was hit, unless he caught the ball, was not put out, but became an active recruit in the ranks of his late enemies. When one base was in this way emptied of its players, the game was over. Played with a common ball, this game was voted extremely stupid, and was rarely indulged in. But with snow-balls it formed a large part of the winter's sport. Played with a number of balls, inside a high inclosure, so that the balls would not have to be chased, it might be made quite exciting.

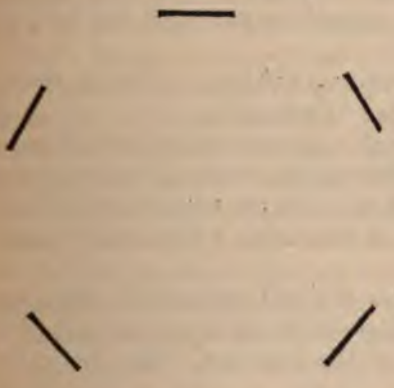
Sometimes the two bases were on opposite sides of the school-house, over which the ball had to be thrown to and fro until caught, before anybody could be hit with it. Whenever it was caught, the two teams changed sides of the school-house, and it was while this exchange was going on that the hitting had to be done. A player could not be hit after he reached "home." As in

"draw-base," the game kept on until one team swallowed up the other. I always heard this game called "ante-over." It was usually played by the small boys and the girls, the latter catching the ball in their aprons. The point was to get around the house and hit some of the other side before they knew the ball had been caught. The bulls and bears of Wall Street make a similar use of monopolized information.

Retaining the bases, and the division into teams or sides, the game of "bull-pen" went away beyond the last two in complexity and interest. It was one of our great games, and the largest boys delighted in it. It furnishes us a step in evolution which we can partly illustrate by a diagram. In the games of draw-base and ante-over there are two parallel bases, thus:



The players all stand on bases, and they all stand on an equality. There is no specialization of duties or privileges. In bull-pen the two bases are subdivided into half as many as there are players, and they are arranged into the circumference of a ring, as shown below.



One player stands on each base. These are the winners of the last preceding game—the "ins." The bases are positions of honor. The outs are a disorganized rabble, roaming about inside the ring. Here is differentiation as well as division. Here is a plain case of evolution.

As in ante-over, the ball must be caught by some player before he can hit anybody with it—unless he has just been hit himself. In fact, it is not "hot" at the beginning of the game until it has passed three times around the bases and been caught each time at every base. After that, any baseman who catches it may throw at anybody inside the ring, who, if hit, must get the ball, and, without going outside the ring, must try to hit some baseman. The basemen have the privilege of running as far away as they please in order to avoid being hit.

In one respect the two sides stand on an equality. The player who misses, or whose ball is caught by the enemy, is out, and excluded from the rest of the inning. If the basemen are all out

first, the other side gets the bases for an inning. If the men in the ring are all out first, they must go back into the ring for another inning. It is possible for one side to hold the bases all day, but in practice the honors are pretty evenly divided.

When all the basemen but one are out, he may choose a partner, and they "smuggle" the ball. They conceal it under the coat of one, and both hold their hands under their coats as if they had it. Then they run the bases, and the enemy, not knowing which of the two has the ball, may be stolen upon and hit. But at any time a baseman can throw only from a base.

This is, so far as I know, the highest development of this class of ball-games. We have traced their natural history from the wanton hitting of one boy by another, through the hole-ball games, in which there are no bases and no sides, and the base-games in which there are two sides standing equal, on two bases, to the numerous bases occupied by one side as a token of victory. We have not yet encountered one of the most important instruments of ball-playing—the bat. This mighty engine of human amusement, whether in the form of a billiard-cue or a croquet-mallet, or what not, brings about radical variations in the game.

There is so much pleasure in the mere batting a ball that many a boy will amuse himself at it entirely alone for hours. He will gently toss the ball upward and as it comes down bat it either upward or horizontally. He will throw it against the barn-side and bat it on the rebound. He will lay the bat across a fulcrum and the ball upon one end of it, and then, striking the other end with his father's axe, drive the ball out of sight into the blue sky, catching it as it comes down. When several play at this, the privilege of striking being earned by catching the ball, the game is called "sky-ball."

If he can get another boy to toss up the ball, and he strikes it upward, the game used to be called "tip-e-up."

If the pitcher throws horizontally, a nameless and stupid game is produced. The pitcher earns the bat by catching the ball when struck. This was always so hard to do, in my experience, that the bat generally seemed in danger of becoming a hereditary possession of the batter.

It was much more fun to throw the ball against the barn, and standing behind the batter put him out by catching the ball when he struck at it and missed it on the rebound. This we called "barn-ball."

It was still better to divide the work of pitching and catching. There is division of labor, as the economists call it, in any batting game. There is also distinction of rank, the bat being always a token of victory—something to be struggled for and won. In all two-handed games the pitching, catching, fielding, etc., are all

done by a single player. In a three-handed game the work is further divided, there being now a batter, a pitcher, and a catcher. This we used to call "one old cat." The three players occupied the same positions now held by the same three players in the great American game.

Bases were now introduced. When the batter had struck the ball three times, he must run to the pitcher's base before the ball was thrown across his path in front of him. Otherwise he was out, and the player who "crossed him out" got his bat. There were, therefore, three ways of securing his bat: by catching the ball when he had struck it, by catching it when he had struck at it, and by crossing out when he ran bases. And there were two players at work trying to accomplish the object. The batter's life was rendered far less easy by these new features. Of course, every time the batter ran, the pitcher and catcher, instead of changing places, changed occupations.

If another batter was added, the two occupations of pitcher and catcher merged back into one. This was "two old cat." Its rules were usually the same as in the preceding game; but sometimes, instead of "every fellow for himself," it was "one out, all out." It was then a game of partners, like whist.

There was also "three cat," or "three-cornered cat," and even "four cat." The rules were the same.

One important difference between the batting and the hitting games was that, in the former, the complexity of the game increased with the number of players, while, in the latter, the simplest games were those in which the whole school could join. Up to eight players, the simple "old cat" games were the commonest. With more players than eight we usually played "town-ball." It was plainly evolved out of the cat games, for it retained all their rules. And it forms a connecting link between them and base-ball. But it resembles "one cat" more than any of the other forms of cat-ball. It might be called a lateral branch of the cat family, just as the lion and the tiger are related to the common cat. In ball-games the cat family had two principal lines of evolution. Along one line it bloomed into two, three, and four cat, and along the other line into town-ball, the professional base-ball, and one or two other allied forms.

Along the first line there was a mere cumulation of cats. All that is implied by this expression is that there was a multiplication of batting bases. After "one cat" there was just one batter and one catcher to each batting base.

In the other line we revert to the single batting base, regardless of the number of players. Even in "one cat" there were two, which were used alternately by the batter. His run was from one batting base to the other. Every time he ran, his former pitcher

became his catcher, and his catcher, pitcher—just as in the lower animals the same organ often has various functions to perform by turns. Just so, too, in rude societies, trades afterward widely separated may be united in the same person—as, for instance, the professions of barber and physician used to be united.

In the town-ball games, the pitcher was always pitcher until the game was ended or his arm was tired. The catcher was always catcher one game through, unless his hands blistered or his incompetency became apparent. In the professional games these two have permanent and well-paid positions. All the advantages mentioned by economists as resulting from "division of labor" are here illustrated.

In these games the conspiracy against the batter's peace of mind reaches appalling proportions. The conspirators are an organized band of indefinite numbers. Their lives are consecrated to the single end of putting him out. Even in "town-ball" one man has nothing to do but pitch him deceptive balls. Another has nothing to do but catch the balls he misses or only "ticks" or knocks foul. All the rest are scouring the field for his "flies," or stopping his "grounders" and crossing him out.

To add to his burdens, he is forced to run four bases instead of one. It was sufficient for any one of his numerous enemies to throw the ball across his path between him and the base to which he was running. This hardship is somewhat mollified in professional base-ball.

In "town-ball" there was as yet no distinction between basemen and fielders. After the pitcher and catcher had been selected, the others on that side went where they pleased; and they did not get the bat until they had put all the batters out. Nay, when all but one had been put out, he could sometimes call back to his assistance any one he chose of his slaughtered comrades; and he often had a rubber ball which, if he did not burst it, he could drive to the other side of the hay-field.

The professional batter has to contend with a curved ball, and go out when three of his comrades are out. But, on the other hand, the ball has to be pitched to him within definite limits, and he has to be touched with it when running.

Except mechanical details and minor rules changeable from year to year, these are all the differences between town-ball and base-ball. The rules were not so strict in the former, and there was no umpire to enforce them. They were often adopted by unanimous consent at the beginning of the game. One rule, often but not always adopted, was that the batter who knocked the ball over the fence was out. Another was that, when all the batters but one were out, one might be called back to "run bases." He had to make home runs—three of them within a maximum limit

of nine strikes. This was the most exciting part of the game, but was not a standing privilege.

Our good town-ball players developed into good base-ball players, and took to it quite naturally. In fact, the two might almost be called the same game under different names and at different ages. I believe it is quite common to speak of them in that way. Our town-ball was probably called base-ball in that part of the country where the game first began its rapid development; but, by the time the developed game had reached us, it was so different that for some years the two games were played side by side, each retaining its old name.

What caused this sudden development? The ingenuity and the wrangling of the boys had refined the game until adult men all at once saw the merit in it. Up to this point its rules had been wrought out and fought out on the vacant town lot or in the meadow surrounding the country school. It was pretty well understood that, unless fair rules were agreed on and held to, somebody would get hurt. The cry of "'Tain't fair!" would be raised and persisted in by the party infringed on. The other boys would soon tire of having the game delayed; and many a time have I seen them stop right there and adopt a new rule covering the case. It was always, as in the affairs of men, the courage and determination of the oppressed which brought about evolution and progress. It was the necessity of admitting reasonable claims and adopting acceptable rules in order to keep the peace and save time and strength.

When by these processes of ingenuity, goaded on by conflict, the boys had made it really a fine game, the men took hold of it and pushed it forward more rapidly, as men ought. They held their quarrels and set their rules in hotel parlors. They are still at it; and I should not like to say that many legislative bodies are engaged in business either more harmless or more profitable. Certainly a good many persons recuperate in worse ways than watching

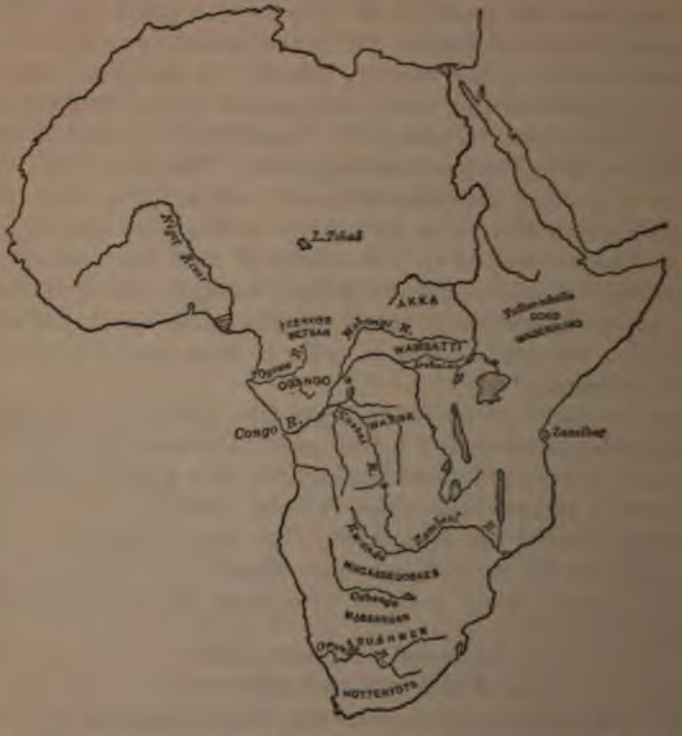
> "Jist a passel o' big men a-playin'
> A little boys' game with a ball."

MISTAKES in orientation usually result from some incidental and temporary bewilderment, which may, under peculiar circumstances, overtake any one. Instances are cited by Sir Charles Warren in which they are chronic. Erroneous conceptions formed by children as to distances and positions may grow up with them undetected till near their maturity. Then, when the defect is revealed, it will be too late to apply any other remedy than to recognize it, and make such allowance for it as is possible. Probably few persons have grown up without forming some errors of the kind which they have found it impossible to get rid of. The defect may account for some of the accidents that occur on railways and shipping.

THE AFRICAN PYGMIES.

By A. WERNER.

NOT the least interesting of the discoveries made by Mr. Stanley on his latest expedition is that of the Wambatti—the dwarf tribe living between the upper Aruhwimi and the Nepoko. It has long been a well-known fact that the Pygmies of Homer, Herodotus, and Ktesias—those of whom Pliny speaks as "dwelling among the marshes where the Nile rises"*—are something more than mere mythical beings; and almost every exploration of any importance undertaken of late years has thrown fresh



light on the existence of a primitive African race, of whom the Wambatti, Akkas, Obongo, Watwa, and Bushmen are, in all probability, scattered fragments.

A glance at the accompanying rough map will show how numerous are the tribes—usually designated dwarfs or pygmies—whose marked resemblance to each other, and marked difference from the people among whom they are scattered, are recognized

* Hist. Nat., vi, 35.

facts. The physical characteristics in which, broadly speaking, they all agree, are their small stature, their light-yellow or reddish-brown color, and the peculiar character of the hair, which is woolly, but, instead of being, as in the negro, evenly distributed over the scalp, grows in small tufts—"cheveux plantés en pinceaux de brosse," as Emin Pasha puts it in speaking of the Akkas.* This appearance, according to Prof. Virchow, is not due to the fact that the hair grows on some spots and not on others, but to a peculiarity in the texture of the hair itself, which causes it to roll naturally into closely curled spiral locks, leaving the intervening pieces of scalp bare. Be this as it may, this growth is the surest and most permanent characteristic of the Pygmy, or, as some prefer to call them, the Hottentot-Bushman race.†

The name of dwarfs, applied by some to these people, has been objected to as implying deformity or arrested growth, and therefore conveying a wrong impression. Nothing of the kind can be said of the African Pygmies, who, though of short stature, are well-shaped people of perfectly normal formation. It is true that the Hottentots and Bushmen show certain strange anatomical peculiarities; but these may be said to be more or less accidental, being, in part at least, the result of special and unfavorable conditions of life.

The Pygmies are nomadic in their habits,‡ and neither keep cattle nor till the ground, but live by hunting and snaring wild animals and birds, or, under the most unfavorable circumstances, on wild fruits, roots, and berries. Their weapons are always bows and arrows, the latter usually poisoned—the resource of the weak. They have no fixed abode, and, if they build shelters at all, only construct rude huts of branches. They have no government, nor do they form regular communities; they usually wander about, like our gypsies, in hordes composed of a few families each. This,

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* Transactions of the Berlin Anthropological Society for 1886.

† Prof. Flower, however, thinks that differences between the Akkas and Bushmen are so radical as to preclude the possibility of regarding them as members of the same race. He lays special stress on the yellow complexion and "peculiar oblong form of the skull," which is especially distinguished from that of the Akkas by the absence of prognathism; also on the "special anatomical characters" alluded to later on. But it seems to be the case that modern research tends to show that environment and conditions of life, etc., may act far more quickly in the production of racial peculiarities than was formerly supposed. There are instances, e. g., on record of the children of white, or at most tawny parents, born in a hot, damp locality (to which the latter had migrated from a dry one) being positively black. The Bushmen have been isolated to such a degree from their more northern congeners, and the struggle for existence has been in their case so severe, that they may well have developed striking differences. It should be noted that their habitat is dry, while that of the Akkas is extremely hot and damp.

‡ Les Akkas ne forment point un peuple compact; il n'y a pas un pays aux Akkas; comme les volées des oiseaux, ils sont un peu partout.—Emin Pasha.

however, depends on the nature of the country—in the parched deserts of the south they are not even united to this extent. Sometimes they are to a certain extent dependent on more powerful tribes, who afford them protection in return for certain services. Their notions of the Unseen, when they have any, would appear to be of the very crudest. Their languages seem to be distinct from others, related among themselves, and very peculiar. This is a point to which I shall revert later on.

Leaving aside the classical writers,* the earliest reference to the Pygmies occurs in the narrative of Andrew Battell,† who spent three years in the kingdom of Loango during the first decade of the seventeenth century. He says:

To the north-east of Mani Kesock are a kind of little people called Matimbas, which are no bigger than Boyes of twelve yeares olde, but verie thicke, and live onely upon fleshe, which they kill in the woods with their Bowes and Darts. They pay tribute to Mani Kesock, and bring all their Elephants' teeth and tayles to him. They will not enter into any of the Marombos' houses, nor will suffer any to come where they dwell. And if by chance any Marombo, or people of Loango passe where they dwell, then they will forsake that place and go to another. The Women carry Bow and Arrowes as well as the men. And one of these will walk in the Woods alone, and kill the Pongo with their poysoned Arrowes.

The Flemish geographer Dapper, writing in the seventeenth century, refers to the Pygmies in the following passage:

Before the King's cloth sit some Dwarfs, with their backs towards him; Pigmies indeed in stature, but with heads of a prodigious bigness; for the more exact deforming whereof they wear the skin of some Beast tied round about them. The Blacks say there is a Wilderness where reside none but men of such a stature, who shoot those Gigantick Creatures, the Elephants. The common name of these dwarfs is Bakke-Bakke; but they are also called Mimo's.‡

These Bakke-Bakke (whose name reminds us of Akkas, Tikki-Tikki, and Wambatti, and possibly Batwa) seem at first sight to come under the heading of true dwarfs, or natural malformations; but the disproportioned heads may be an accidental mistake magnified by report. The other items of the account tally with the descriptions of Battell and others—the skins of beasts, worn "for the more exact deforming of the head," are probably the leopard and monkey skin caps worn among many of the Congo tribes at the present day.

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* An excellent summary of what is said by these, and also of modern discoveries up to 1871, is given in an article, Ueber Zwergvölker in Africa (to which I have been greatly indebted in the preparation of this paper), in Petermann's Mittheilungen for that year.

† Purchas, vol. ii, p. 983.

‡ Description of the Kingdom of Lovango, or the Countrey of the Bramas in Nether Ethiopia. (Africa: Collected and translated from most authentick Authors. By John Ogilby, Esq. 1670.)

De Commerson, who accompanied Bougainville on his voyage round the world, and visited Madagascar in 1771, heard of a small race in the interior of that island, called Kimos or Quimos, and actually saw one woman—a slave in the household of the governor of the French settlement, the Comte de Modave. De Modave collected all the information he could about the Quimos from native chiefs, but never succeeded in reaching the valleys where they were said to live, or meeting with any, except the slave-woman before mentioned, who may or may not have been a typical specimen. Ellis and other missionaries, in later times, heard of these people under the name of Vazimba, but never appear to have seen them; and it may be doubted whether any of them exist at the present day. The native statements preserved by De Commerson and De Modave would, if true, show the Quimos to have been in some respects physiologically different from the rest of mankind; but these statements—and rightly so, in the absence of further evidence—are treated by both gentlemen with extreme caution. For the rest, the description of the Comte de Modave's Quimo slave might very well stand for the portrait of the average Bushwoman.

Captain Boteler, who was on the east coast of Africa, between the years 1821 and 1826, heard of a tribe of small people, living in the interior, called Waberikimo; and reports of these seem at different times to have reached Zanzibar. The native information on this point was somewhat vague; but from all accounts they would appear to be the same as the Doko, of whom Dr. Krapf received a description in 1840 from a slave of the name of Dilbo, a native of Enarea. The Doko were said to live in the Galla country; they were small in stature, and of a dark olive color. They lived on fruits, roots, mice, and wild honey, and were unacquainted with the use of fire. They had neither weapons, houses, nor temples, nor even, like the Gallas, sacred trees. Yet they had some notion of a Supreme Being, to whom, under the name of *Yer*, they sometimes addressed prayers, "in moments of sadness and terror," said Dilbo. There is a certain pathos in what follows; but we must remember that it was filtered through the imagination—perhaps elicited by the leading questions—of a kind-hearted German with a touch of poetic mysticism about him. "In their prayer they say: 'Yer, if thou dost really exist, why dost thou let us be slain? We ask thee not for food or clothing, for we only live on snakes, ants, and mice. Thou hast made us, why dost thou let us be trodden down?'"

The Doko had neither chiefs nor laws; they "lived in the woods, climbing trees for fruit, like monkeys"; but diseases were unknown among them, and they were much liked as slaves in Enarea, being docile and obedient.

Dr. Krapf again heard of the Doko in Ukambani and at Barawa, and at the latter place even saw a slave corresponding to Dilbo's description. Father Léon des Avanchers, a French Roman Catholic missionary, heard of them from the Somalis in 1858, under the name of "Tchin-Tchellé" (which is, being interpreted, *Quel miracle!*). In 1864 he saw some of them for himself in the kingdom of Gera (north of Kaffa, in Abyssinia), and described them in a letter to M. d'Abbadie, published in the Bulletin of the Paris Geographical Society. The word Doko may be another form of the Swahili *mdogo* (= small), but this has been disputed.

Proceeding in geographical rather than in chronological order, we come next to the Akkas, with whom Colonel Long's Tikki-Tikki* would seem to be identical. They were first heard of, vaguely, by Petherick, in 1854; but the first real announcement of their existence to the civilized world was made by Dr. Schweinfurth in 1871. They live in the Monbuttu country, which lies south of the Bahr-el-Gazal and west of the Equatorial Province of Egypt. Dr. Schweinfurth's account has been ably supplemented by Dr. Felkin and Emin Pasha, the latter of whom enjoyed ample opportunities for studying them during the twelve years he spent in Central Africa, and in 1886 communicated to the Berlin Zeitschrift für Ethnologie a very valuable and interesting paper on the subject, accompanied by detailed measurements. He insists on the distinction between the Akkas and real dwarfs (i. e., persons whose growth has been arrested by pathological or other causes), of whom he saw several at Mtesa's court. "Tout au contraire, les Akkas sont une race qui n'offrent aucun signe pathologique, mais qui, formés à point, déprécieraient bien vivement les épithètes de 'race déchue,' de peuplade vouée à l'extinction, dont on a bien voulu les gratifier." They live in bands composed of a few families each, putting up the rough shelters of reeds and branches which form their temporary camp in the woods, near some running stream, and usually within reach of a Monbuttu or Momvu village. They are good marksmen, and kill even elephants and buffaloes, bartering with the villagers the meat they do not require for themselves, in return for grain, oil, native beer, and other necessaries. The Monbuttu, moreover, obtain from them all the skins and feathers used by them for clothing and ornament; and any chief who should refuse hospitality to the Akkas would not only forfeit these supplies, but draw down the speedy vengeance of the little people the first time he or any of his tribe ventured into the forest alone. The Akkas are cannibals, and make no secret of the fact; those personally known to Dr. Schnitzer "savaient parfaitement me dire quelle part du corps

* Central Africa. By Colonel C. Chaillé-Long. London, 1876. Pp. 263 *et seq.*

humain soit la plus savoureuse."* The average height of some thirty individuals measured by the pasha was 1·36 metre. They are usually of a lighter brown than the Monbuttu, but the difference of coloring is rather in the *tone* than in the *shade*—in other words, the Akkas are of a *red*-brown, the Monbuttu of a *yellow*-brown.† Their hair is black-brown or quite black, growing in tufts, as already described, short and very woolly, and too scanty to be made into the ornamental coiffures so much in vogue among the Africans. There is an abundant growth of hair all over the body, and "it can not be denied that the mouth resembles that of certain apes." This is noteworthy when contrasted with Dr. Wolf's remark on the Batwa, "Irgend welche pithecoide Merkmale waren nicht vorhanden." The Monbuttu frequently intermarry with the Akkas, and half-breeds are far from uncommon. Two Akkas were sent to Italy by Signor Miani, one of whom, we believe, is still living at Verona.

The Wambatti, first made known to the world by Mr. Stanley's narrative, live farther west than the Akkas, from whom they do not appear to differ materially—unless it be in the "spiteful and venomous" disposition evinced by their unprovoked attacks on the expedition; whereas the Akkas, though dangerous on provocation, are tolerably peaceable when well treated.

Within the great horseshoe bend of the Congo, and apparently ranging over a vast extent of country, dwell the Watwa or Batwa. Mr. Stanley first heard of them in 1876, from Rumanika of Karragwé, and, later on, at Nyangwé, from Abed bin Jumah, who, in a singularly picturesque and graphic narrative, recounted the tragic history of Sheik Mtagamoyo, the cruel and dauntless—how he fitted out a strong caravan for the country of the dwarfs, expecting to make his fortune in ivory, and went back poorer than he came.‡ Stanley did not himself come in contact with these Watwa, except in the person of a single individual who was brought in by his men at Ikondu, on the upper Congo or Lualaba River.* He measured three feet six inches and a half in height, was "light chocolate" in complexion, and carried a bow and poisoned arrows.

Mr. H. H. Johnston,‖ in 1883, saw two slaves among the Bayansi, near the Kwà River, who probably belonged to this race.

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* Thus differing from Winwood Reade's Fan acquaintance, who assured him that, considered as a dish, man was "all alike good."

† "Tandis que les Akkas appartiennent aux peuples nègres dont le fond du noir est *rouge*, les Mombouttous montrent un brun ou noir au fond *jaune*." This appears to contradict the general tenor of what has been said about the Pygmy races, but it is probable that no hard-and-fast rule can be laid down as to color.

‡ Through the Dark Continent, pp. 390–393.

* Ibid., pp., 435, 436.

‖ The River Congo, p. 215.

More extended observations were made in 1885 by the late Dr. Ludwig Wolf, who accompanied Lieutenant Wissmann's expedition, and spent some time in the Kassai region. He says that the Batwa in some places live side by side with the Bakuba—in others they have settlements of their own, hidden away in the dense forest. They are most numerous about the parallel of 5° south. Each sub-chief of the Bakuba has a Batwa village assigned to him, whose inhabitants supply him with palm-wine and game. The independent Batwa of the forest sometimes offer dried meat in exchange for *manioc* or maize to the Bakuba, at periodical markets held on neutral ground. Dr. Wolf experienced some difficulty in obtaining accurate measurements; but the first series of those he was able to record gave 1·44 * metre as a maximum, and 1·40 m. as a minimum. On a later occasion he found that the heights obtained ranged between 1·30 m. and 1·35 m.—which last figure is somewhat less than that given for Stanley's dwarf.

Dr. Wolf was disposed to think that there is in this respect little if any difference between the Batwa and the Bushmen. For the rest, he says that they were in general tolerably well formed, "und machten durchaus den Eindruck des Normalen." The skull was not markedly prognathous, and no ape-like peculiarities were noticeable. They followed no particular custom in the disposal of their dead, and were, like other Africans, firm believers in witchcraft.†

According to Major Wissmann, these Batwa hunt with dogs, and, indeed, possess a superior breed of greyhounds.

Mr. C. S. Latrobe Bateman, in Under the Lone Star, speaks of two nomadic tribes—the "Batwa Bankonko" and the "Batwa Basingi"—the former of whom were the terror of the Bakete, who, to obtain protection from them, became tributary to the Bakuba. He makes no mention, however, of their racial peculiarities.

The Obongo, discovered by Du Chaillu in 1865, inhabit the Ashango country, in the mountains south of the Ogowé. They were "stoutly built, like chimpanzees," with broad chests and muscular limbs; some of them were not more than four feet in height, others from four feet two inches to four feet seven inches. They were "of a dirty-yellow color," with hair growing in tufts; and lived in the same sort of relation to the Ashangos as the Batwa to the Bakuba. A full description of their settlement and its little circular huts made of branches may be found in Du Chaillu's Ashango-Land.‡

The same people were seen by Dr. Lenz, when he ascended the

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* About four feet nine inches and a quarter.

† Transactions Berlin Anthrop. Soc., 1886.

‡ Pp. 315 *sqq.*

Okanda (a tributary of the Ogowé) in 1874. He found that they were called "Babongo," and also "Vambuta" (Wambatti ?), though their real name appeared to be Bari or Bali. As he did not penetrate farther than 12° east, he did not reach their actual dwelling-places, which were said to be a fortnight's journey beyond that point, though he saw and measured a considerable number of individuals. His measurements range between 1·32 and 1·42 metre, and he particularly notices the contrast between their round huts and the rectangular style of architecture prevailing in the district.*

Somewhere to the north of these, perhaps, may be placed the Kenkob and Betsan, of whom Dr. Koelle, the learned author of the Polyglotta Africana (1854), heard at Sierra Leone. He obtained his information from two liberated slaves, one of whom, a man named Yon, was a native of a country called Bayon, supposed to lie about 5° north, and between 12° and 13° east. This man declared that four days' journey eastward from his home there was a great lake called Liba, on whose banks lived the Lufum tribe, "tall, strong, and warlike; clad in black monkey-skins, and fighting with spears and arrows. Near Lufum," the account continues, "and also on the shores of the Liba, is another people, called Kenkob, only three or four feet high, but very stout, and the most excellent marksmen. They are peaceful, live on the produce of the chase, and are so liberal that if, e. g., one has killed an elephant, he would give the whole of it away."

Another man, whose home was to the northwestward of Bayon, gave Dr. Koelle a very similar account of a tribe called "Betsan," living "on the river Riba,† which comes from Bansa and goes to Bambongo." These, too, are successful hunters, and are also said to make bark cloth for themselves, whereas Du Chaillu's Obongo wore nothing but the cast-off grass cloths of the Ashangos. The Betsan sometimes exchange their venison for millet, etc., in the Rufum country. "They do not cultivate the ground, but are constantly on the move, changing their abode every six or twelve months. Their houses can be easily built, taken down, and even carried along with them, consisting as they do of the bark of a large tree. The Betsan hunt monkeys, baboons, wild hogs, deer, elephants, etc." ‡

I can suggest no affinity for the names here given to the Pygmies, unless Kenkob contains a possible reminiscence of "Khoi-Khoi," or "Koi-Koib," the tribal name used by the Hottentots among themselves. It is utterly unlike a Bantu word, and may be a relic of the language originally common to all the Pygmy tribes,

* See Petermann's Mittheilungen for 1877 (p. 108); also Dr. Lenz's paper in the Transactions of the Berlin Geographical Society.

† Evidently the same as Liba; as Rufum-Lufum. ‡ Polyglotta Africana, p. 12.

which many of them seem to be losing. Bambongo, on the other hand, distinctly suggests Obongo, and may have originated the latter name (which, as the variant *Ba*bongo shows, seems to be Bantu)—the Kenkob adopting it from the district where they had sojourned. Or, again, it may be a tribal name, reported to Dr. Koelle's informant as that of a district.

Turning to southwestern Africa, we find that Major Serpa Pinto,* in 1878, met with a tribe called "Mucassequeres," living in the forests between the Cubango and Cuando, while the open country is occupied by the Ambuellas. These people have "eyes very small and out of the right line, cheek-bones very far apart and high, nose flat to the face, and nostrils disproportionately wide." Their hair is crisp and woolly, growing in *separate patches*, and thickest on the top of the head. Unlike the Obongo, they build no kind of shelter, but, like them, are skilled in the use of bows and arrows, and live on roots, honey, and game. In color they are "a dirty yellow, like the Hottentots, while the Ambuellas are black, though of a Caucasian type of feature."

Farther south, near the borders of the Kalahari Desert, Serpa Pinto found a tribe similar in most respects to the Mucassequeres, but deep black, and known by the name of Massaruas. These (who are less savage than the Mucassequeres) are probably a tribe of Bushmen, very much resembling, if not identical with, the M'Kabba, or N'Tchabba, brought by Signor Farini from the Kalahari Desert. These last were carefully examined by Prof. Virchow, and described by him in a paper read before the Berlin Anthropological Society, March 20, 1886.

We have now to notice the section of the Pygmy race with which Europeans have come most in contact—the Hottentots and Bushmen. The Hottentots (as they are now known to us, their real name for themselves being "Khoi-Khoi" †) represent probably the highest development of the race, and differ notably from its other members in being a pastoral people. When Van Riebeek landed at the Cape in 1652 they existed in great numbers, roaming the country with large herds of cattle. Kafir wars and Dutch "commandoes," with other causes, have so far thinned them out that few if any genuine "Cape Hottentots" now exist, their place being taken by the Griquas and other tribes of mixed race. Two cognate tribes, the Korannas ‡ and Namaquas, still exist, but in diminished numbers.

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* How I crossed Africa, vol. ii, pp. 320 *seqq.*

† Or Koi-Koib ("men of men"), according to Dr. Cust. The Kafirs call them "Lawi." "Hottentot" is merely a nickname given by the early Dutch settlers, who declared the natives spoke an unintelligible language, consisting only of sounds like *hot* and *tot*.

‡ Some ethnologists are inclined to look on the Koranna tribe as a cross between Hottentots and Bushmen.

That keen observer, Moffat, as long ago as the first decade of this century, noticed the distinct and peculiar characteristics of the Hottentots, and recognized their racial identity with the Bushmen. He speaks of "that nation, which includes Hottentots, Korannas, Namaquas, and Bushmen," and describes them, as a whole, as "not swarthy or black, but rather of a sallow color, and in some cases so light that a tinge of red in the cheek is perceptible, especially among the Bushmen. They are generally smaller in stature than their neighbors of the interior; their visage and form very distinct, and in general the top of the head broad and flat; their faces tapering to the chin, with high cheek-bones, flat nose, and large lips." He further notes that the first three speak languages which are mutually intelligible, while that of the Bushmen, though cognate, is quite distinct. Writing (after his return to England) in 1842, when as yet the Akkas and Batwa were unknown to science, he suggests that, "when the sons of Ham entered Africa by Egypt, and the Arabians by the Red Sea, the Hottentot progenitors took the lead and gradually advanced, as they were forced forward by an increasing population in their rear, until they reached the ends of the earth." He further remarks, "It may also be easily conceived by those acquainted with the emigration of tribes that, during their progress to the south, parties remained behind in the more sequestered and isolated spots where they had located while the nation moved onward, and research may yet prove that that remarkable people originally came from Egypt." In corroboration of this theory he mentions having heard from a Syrian who had lived in Egypt of slaves in the Cairo market, brought from a great distance in the interior, who spoke a language similar to that of the Hottentots, and were not nearly so dark-colored as negroes in general. These must certainly have been Akkas.*

As for the Bushmen, we have pretty full accounts of them from various sources. Moffat has much to say about them—too much to quote in full—which may be found in the first and fourth chapters of his Missionary Labors in South Africa, and is supplemented by Livingstone in the Missionary Travels.

Mr. Alfred J. Bethell (in a letter to the Standard which appeared on April 26, 1889) says that the Bushmen proper are now "nearly if not quite extinct," the people now so called being outcasts from the Matabele, Bamangwato, and other Bantu communities. Mr. A. A. Anderson,† however, who extended his

* Winwood Reade's remark (African Sketch-Book, vol. ii, p. 528), written in 1873 or earlier, is worth notice: "His (Du Chaillu's) discovery of the Dwarfs (*who are certainly Bushmen*) is an important contribution to the ethnology of Africa."

† Twenty-five Years in a Wagon in South Africa, vol. i, pp. 235, 282, etc.; vol. ii, p. 74.

journeys far beyond the northern limits of the Transvaal, makes frequent mention of them and discriminates four distinct types, noticing especially a very light-colored variety only found in the Drakensberg Mountains and the ranges west of them. There seems to be a tradition of hostility between the Bushmen and Hottentots, and the difference between them in pursuits and habits has always been sharply marked; but the fact of their affinity has seldom or never been questioned. Moffat distinctly states his belief (supported by the analogy of the Balala or outcast Bechuanas) that they are the descendants of Hottentots driven by want and the hostility of stronger neighbors into the desert. Generations of perpetual living on the edge of starvation have made of them the gauntest and skinniest of shapes—seemingly designed by Nature to show what human beings can endure in that line and live—and developed in them, in spite or because of their physical weakness and insignificance, a cunning and an intimate knowledge of nature that to the savage mind seems little short of superhuman. Some of the Kafirs believe that the Bushmen can understand the language of the baboons, and countless instances of their skill in tracking game and finding water are on record. They possess a wonderful gift of mimicry, can imitate to the life the action of any man or animal, and have a passionate love of music. They can evolve from their primitive instruments—the *gorah*, with its catgut and quill, or the hollow gourd-shell, with strings stretched across it—plaintive melodies of a surprising sweetness, very different from the hideous *tintamarre* of horns and tomtoms which delights the heart of the average African. Moreover, having a quick ear and a retentive memory, they will pick up and repeat any civilized tune once heard—whether the *Chorales* of the German Mission or the more secular ditty sung by the wandering traders. Their poisoned arrows, and their noiseless, furtive ways of coming and going, inspire the stronger races with a vague dread of them, strengthened no doubt by that uncanny something which, as Mr. F. Boyle remarks, "makes a Bush-boy resemble a bird the more, the more he shows a simian intelligence."

We have thus, in a hasty and imperfect manner, surveyed the known fragments of the aboriginal African race. We have seen that they resemble each other to a great extent in physical conformation and in manners and customs; the differences being for the most part due (like the extremely poor development and degraded way of life of the Bushmen) to differences in habitat and environment. The Hottentot and Sàn or Saab (Bushman) languages we have seen to be related, though distinct; and they are radically different from every known Bantu tongue. Some have even denied that they are articulate speech at all. The peculiarity

of the "clicks" has often been insisted on;* another distinguishing characteristic is the existence (at least in the Hottentot language) of grammatical gender—a feature wholly absent from the Bantu tongues. The Bushman language is said to be monosyllabic. The Hottentots, however, now mostly speak Dutch—or that variety of it to be heard at the Cape—and probably both languages are on the way to extinction. It is said that "a missionary, being invited by the Government to send books in the Kora† dialect to be printed, remarked that his experience was that it was easier to teach the young to read Dutch, and that the old could not learn at all."‡

An examination of the list of Batwa words collected by Dr. Wolf, as compared with his Baluba and Bakuba vocabularies, and the Congo and Swahili languages, has convinced me that the Batwa, if they have not adopted and modified the speech of their neighbors, have at any rate adopted a great many Bantu words into their own. The numbers up to ten, for instance, are identical (with slight differences of pronunciation) in the Batwa and Baluba languages. But as yet the materials for comparison are too scanty for any definite statement to be made. The few words elicited from the dwarf met by Stanley were, as Mr. Johnston points out, decidedly Bantu; but we need not conclude from this that the Pygmy race consists merely of outcast and degenerate Bantus. What more likely than that a small and isolated tribe, who, like the Batwa, frequently had friendly intercourse with surrounding and more powerful tribes, should, to a certain extent, adopt the language of the latter?

Surveying the Pygmy race as a whole, we find them—shorn of the mythical and magical glamour with which distance and mystery had invested them—not so very different, after all, from other human beings, but still sufficiently interesting. There is a shock of disillusion in passing from the elves and trolls of a past age—not to mention Alberic of the Nibelung's Hoard—to the worthy but prosaic Lapps of the present day; and the "little people" of whom Bwana Abed entertained such a vivid and unpleasant recollection were doubtless minimized in stature by the retrospective imagination. No well-authenticated adult Mtwa, Akka, or Mbatti seems to be much less than four feet six inches; while Dr. Petermann thinks that the Pygmies, on the whole, run about a head shorter than the average negro. This may be disappointing to those who are ever on the lookout for the marvelous—by which they mean the abnormal—but the facts as they stand pre-

* Some of the Kafir languages possess these clicks, but they have undoubtedly been borrowed.

† Spoken on the Orange River.

‡ Modern Languages of Africa. By R. N. Cust.

sent quite sufficient food for thought to a more rational frame of mind.

I can not attempt to deal with the origin of the Pygmy race, or its relationship to the Andamanese and the Veddahs of Ceylon, who are said to have some characteristics in common with them. But it seems clear that they were once spread over a great part if not the whole of the continent; that they were broken up and partially exterminated by the advent of the stronger dark races; and that, as a race, they are passing away. It is interesting to look at an analogous case in Europe. A race of small stature, slight frame, and comparatively low type, scarcely, if at all, advanced beyond the hunter stage, occupied the British Islands and the northwestern part of the continent. They were partly massacred or enslaved, partly driven into the mountains by their Celtic conquerors; and in the lonely recesses of the hills and woods—what with their weakness and their strength, their cunning and their skill in metals, their music and their underground dwellings, and their strange, uncanny wisdom—a growth of legend and poetry sprang up about them, till they were no longer known save as elves, gnomes, trolls, or "Good People," whom one dared not name.

It is somewhat suggestive, as bearing on the question of the original immigration into Africa, to note that there was, as late as the sixteenth century, a Pygmy tribe living in Arabia, who may well have been a detachment left behind when the main body crossed the Isthmus of Suez. So far as I am aware, the only authority for this fact is Lodovico di Bartema, otherwise known as Ludovicus Wertomannus, whose narrative of a visit to Mecca (about 1500) is contained in vol. iv of Hakluyt's Voyages. This account runs thus:

> In the space of eyght dayes we came to a mountayne which conteyneth in circuit ten or twelve myles. This is inhabited with Jewes to the number of fyve thousand or thereabout. They are very little of stature, as of the hyght of five or sixe spannes, and some muche lesse. They have small voyces like women, and of blacke colour, yet some blacker than other. They feede of none other meate than goates' fleshe. They are circumcised, and deny not themselves to be Jewes.

This last sentence, apparently, contains the evidence for their Judaism. It is now well known that the rite in question is commonly practiced in Africa, and by the Hottentots, among others. What has become of these "Jewes" does not appear. Probably they have gone the way of nearly all the Bushmen. Will the Akkas and the rest follow them? As a race they are doomed to pass away; yet this need not imply—we hope it does not—that they are to be massacred, or starved out of existence. It was long believed that the Celtic Britons had been utterly exterminated

(except in Wales and Cornwall) by the Teutonic invaders, whom the older school histories taught us to consider as our exclusive ancestors. When the existence of the older, dwarfish, Euskarran or Neolithic race was discovered, it was at first supposed that they had in like manner been made a clean sweep of by the Celts. Recent researches have made it probable that this was by no means the case; indeed, Mr. Grant Allen thinks that there is a considerable Euskarran element in the English population of to-day. The black-haired aborigines—what was left of them—gradually amalgamated with the light-haired and blue-eyed Celts; and these were, in turn, absorbed by the English properly so called. And we have seen that the Griquas and other mixed races exist in Cape Colony, some, at least, of whom have shown themselves capable of being respectable and useful in their generation; and it is at least possible that these mixed races may survive, and in time amalgamate with the Bantu.—*The Gentleman's Magazine.*

THE MIGRATION OF SYMBOLS.

By the COUNT GOBLET D'ALVIELLA.

I.

MEN, to communicate their thoughts, address themselves sometimes to the ear, by speech, song, or music; sometimes to the eye, by gesture, drawing, and the plastic arts generally, including writing. These modes of expression may have an imitative character, as when a savage describes an animal by its cry, or as in a photograph; but even then they have a symbolical bearing, in that they recall only some of the features of the original, and leave the rest to the imagination or to memory. We might define a symbol as a representation which does not aim to be a reproduction. Reproduction supposes that the representative sign is identical with, or at least like, the object represented; symbolism demands only that one may recall the other, by a natural or conventional association of ideas. In this sense there is nothing that may not furnish matter for a symbol. We live among symbolical representations, from the flags over our public buildings to the bank-note in our strong-box; symbolism is mingled with all our intellectual and social life, from the morning hand-shaking to the applause we give to the actor in the evening. Our arts are symbolical, even when they are believed to be only servile imitations of nature. We speak and write in symbols—and even think in them, according to the philosophical systems that are based on our impotency to grasp the reality of nature.

Sentiment, particularly religious sentiment, recurs most largely

to symbolism in order to enter into a more intimate communication with the being or abstraction which it desires to approach. Hence we everywhere see men either adopting natural or artificial objects that remind them of the great absent one; imitating systematically the acts and gestures they assign to it; or objectizing, by processes as various as significant, all the shades of feeling which it inspires in them, from the deepest humility to the most ardent love. Hence the extreme diversity of symbols, which may be divided into two classes, as they consist in acts or rites, or in objects and emblems. We shall occupy ourselves here with the second category, or rather with the figured representations which it has inspired, and which past generations have transmitted to us as material vestiges of their faiths. Studies in comparative symbology fell, toward the second half of the century, into a discredit which is accounted for by their previous history. Syntheses premature as they were brilliant, built up with insufficient and defective materials by the rationalistic school, were succeeded, about fifty years ago, by the system, more philosophical than historical, which found, in all the religious practices of antiquity, the disguised or transfigured reflection of a profound primitive wisdom. These theories all having given way under the contradictions brought against them by discoveries in archæology, ethnography, linguistics, etc., a reaction ensued as extreme as the former infatuation. A disposition appeared to banish hypothesis entirely from all research into the origin and significance of symbols; as if hypothesis—provided it is not treated as an assured fact—were not an essential factor of all scientific progress.

But the situation has greatly changed within thirty-five years. Data permitting comparison under all desirable conditions of authenticity, of the figured representations of different peoples, have accumulated in such proportions that the principal obstacle will lie hereafter in their multiplicity and dissemination. Excavations of ancient monuments in Asia and Africa, the archæological collections of even the smallest states, the societies devoted to every special branch of the subject, and the studies of the whole, directed from the most varied points of view, have made the tasks relatively easy of students who would follow the traces and elucidate the meaning of the principal symbols. On the other hand, the deciphering of inscriptions, the classification and interpretation of written documents, and the general advance of history, of religious history in particular, by informing us concerning the beliefs of peoples, enable us the better to define the relation of their symbols with their myths and their ceremonies, at the same time that a more exact knowledge of the social and geographical medium in which the symbols originated assists us in tracing the origin of the images which have given body to the ideas.

After this there are no reasons why we should not reach as positive results in the study of symbols as in the study of myths. The comparative examination of myths long ago assumed a scientific phase, both with Mr. Max Müller and the linguistic school that is correlating the traditions of nations speaking allied languages, and with Mr. Andrew Lang and his fellow ethnographers who are comparing the mythologies of all known peoples. Now, the myth, which we may define as a dramatization of natural phenomena or of abstract events, offers more than one common trait with the symbol. Both rest on reasoning by analogy, which in the one case creates a figurative story, and in the other a material image. There is, however, the difference that in the symbol we are aware of a distinction between the image and the being or object represented by it, while an essential character of the myth is that the story shall be supposed to be conformable to the reality. But it is easy to see that both are frequently formed by the aid of the same processes and are transmitted by the same ways.

At all events, there are religions that we can not explain unless we endeavor to supplement the insufficiency of the texts by the study of the figured monuments; and there is an increasing disposition among students of particular religions to make use of the texts to prove the symbols, and of the symbols to prove the texts—as in M. Senart's recent works on the history of Buddhism; MM. Gaidoz's and Al. Bertrand's on the symbols of ancient Gaul; those of M. J. Menant on the engraved stones of upper Asia; and those of M. Ch. Lenormant, Clermont-Ganneau, Ledrain, and Ph. Berger on the figured representations of the Semitic religions. These labors are the best demonstration of the services which the interpretation of symbols can render to the history of religions, provided we observe all the rigor of scientific methods.

It is not necessary to insist here upon the interest which the study of symbolism offers, aside from the services which it may be called upon to render to archæological science. Representation by symbolism is, in literature, religion, and art, a necessity of the human mind, which has never been able to content itself with pure abstractions, or to restrict itself to the external shape of things. Under the material and often incoherent forms by which past generations have expressed their aspirations and their faith, we can discern the beating of a heart, the appeal of a soul to other souls, a mind that seeks to embrace the infinite in the finite, to objectize, under features furnished by Nature or the imagination, its conceptions most approaching a reality indiscernible in its plenitude. The symbols which have attracted in the highest degree the veneration of multitudes have often been indeed absurd and gross representations of gods; but what have the gods themselves ever been, except symbols more or less imper-

fect of the Being, superior to all definition, which the human mind has discerned more clearly according to its development, through and above them all?

It seems as if the variety of symbols should be without limits, as are the combinations of the human imagination. But we not rarely find the same symbolical figures among the most distant peoples. Such coincidences can hardly be explained as matters of chance, like the combinations of the kaleidoscope. Aside from the case of symbols found among peoples belonging to the same race, which can be traced back to the common cradle, there are only two possible explanations of them. The images have either been conceived separately, by virtue of some law of the human mind, or they have passed from one country to another by borrowing.

There is a symbolism so natural that, like certain implements peculiar to the Stone age, it does not belong to any particular race, but constitutes a characteristic trait of mankind at a certain phase of its development. Of this class are representations of the sun by a disk or radiating face, of the moon by a crescent, of the air by birds, of water by fishes or a broken line, of thunder by an arrow or a club, etc. We ought, perhaps, to add a few more complicated analogies, as those which lead to symbolizing the different phases of human life by the growth of a tree, the generative forces of nature by phallic emblems, the divine triads by an equilateral triangle or, in general, by any triple combination the members of which are equal, and the four principal directions of space by a cross. How many theories have been built up on the presence of the cross as an object of veneration among nearly all the peoples of the Old and New Worlds! Roman Catholic writers have justly protested, in recent years, against attributing a pagan origin to the cross of the Christians because there were cruciform signs in the symbolism of religions anterior to Christianity. It is also right by the same reason to refuse to accept the attempts to seek for infiltrations of Christianity in foreign religions because they also possess the sign of redemption.

When the Spaniards seized Central America, they found in the native temples crosses which passed for the symbol sometimes of a deity at once terrible and beneficent, Tlaloc; at other times of a civilizing hero, white and bearded, Quetzacoatl, who, according to the tradition, came from the East. They concluded that the cross had been brought to the Toltecs by Christian missionaries of whom the trace had been lost; and, as there must always be some known name to a legend, they gave the honor to St. Thomas, the legendary apostle of all the Indies. Although there were men to defend this theory in the last Congress of Americanists, it may be regarded as definitely rejected. It is now established that the pre-Columbian cross is a wind-rose representing the four princi-

pal directions from which rain comes, and is thus the symbol of the god dispenser of the celestial waters. If the Toltec cross could be related with a similar figure of the Old World, it would rather be the cross of ancient Mesopotamia—where that sign was also adopted to symbolize the four directions of space, and by extension the sky, or the god of the sky, Anou. But it would have to be established first that direct or indirect relations could have existed between the religious art of Mesopotamia and that of ancient America. To remove this hypothesis—even if we refuse to admit the development of a pre-Columbian civilization—it is only necessary to reflect upon the number of centuries that separate the American races from the great empires of the Euphrates and the Tigris. It would be wiser to see in the coincidence the simple result of two courses of reasoning identical in their simplicity.

On the other hand, we can not contest the facility with which symbols have been transmitted. Current products of industry, favorite themes of artists, they have passed continually from one country to another with articles of exchange and objects of adornment: witness the specimens of Hindoo, Chinese, and Japanese symbolical works and iconography which have come to us with the potteries, ivories, cloths, and all the curiosities of the extreme East. Soldiers, sailors, and travelers of every profession in former days could not start on a journey without taking in some form or another their symbols and gods, of which they carried the knowledge to a distance, bringing back in return those of the foreigner. Slavery would likewise favor the importation of symbols by the intervention of innumerable captives whom the fortunes of war or the hazards of piracy brought and caused to flow in from the most distant regions without taking away from them the remembrance of their gods or their worship. Coins, also, have never been wanting to carry to enormous distances the symbols of the nations which issued them: Gallic pieces are only counterparts of the Greek coinage of Philip and Alexander; and pieces rudely imitating Bactrian money have been found in the tumuli of Scandinavia.

Nothing, except perhaps a superstition, is as contagious as a symbol; much more contageous should both be when they are united—as they usually were with the people of antiquity, who seldom adopted a symbol without attaching to it the value of a talisman. Even now there are tourists who come back from Naples with a coral charm hung, according to their sex, from the bracelet or the watch-chain. Do they really believe that they find a defence against the evil eye in this Italian survival of an ancient Chaldean symbol? To many among them it is certainly only a local curiosity, a souvenir; but there are some in the number who

allow themselves to be influenced, unconsciously perhaps, by the Neapolitan superstition. "It can do no harm, and may do some good," they might be tempted to reply to you, as some gamblers do when you jest with them concerning their fetiches. This kind of reasoning is quite general among polytheistic populations, where every one thinks it good to do homage to other peoples' gods, and to unknown gods as well as his own; for who knows which one he may not need in this world or the next? Egyptian scarabs are found by the thousand, from Mesopotamia to Sardinia, wherever the armies of the Pharaohs or Phœnician ships have gone. Everywhere, also, in these regions, native scarabs have been collected, made in imitation of those of Egypt, and reproducing with greater or less exactness the symbols which the engravers of the valley of the Nile lavished upon the faces of their amulets. So also, long before the diffusion of coins, pottery, and jewels, the figurines of Greece and Etruria furnished all central and western Europe with divine types and symbolical images.

Are there any indications that permit us to distinguish whether like symbols have been engendered separately or are derived from the same source? The complexity and oddness of the forms, when they exceed certain limits, go to sustain the second of these hypotheses. The double-headed eagle of the old German Empire has now passed into the arms of Austria and Russia. The Englishmen Barthe and Hamilton were surprised when, traveling in Asia Minor some fifty years ago, they discovered a two-headed eagle of the same pattern engraved among religious scenes in the basreliefs of Pteria, which went back to the ancient Hittites. It is hard to suppose that a representation identical in features, so contrary to the laws of nature, was spontaneously imagined in both instances. M. Longperier furnished a solution to the riddle when he pointed out that the two-headed eagle did not replace the one-headed eagle on the arms of the empire till after the expedition of Frederick II to the East; that it figured at the beginning of the thirteenth century on the coins and banners of the Turkoman princes, then masters of Asia Minor. The latter adopted it as the symbol of all power, perhaps to figure the *hamca*, the fabulous bird of the Mussulman traditions, which carries off buffaloes and elephants as the kite carries off mice. Thus the Turkish race, M. Perrot observes, saw the entrance to the West closed at Lepanto and Belgrade by the eagle which had led it triumphantly on the banks of the Euphrates, and the image of which it also had borrowed from the sculptures cut by its predecessors on the rocks of Eniuk and Jasilikaïa.

If sufficient indications can not be drawn from the form, identity of signification and use may give strong presumptions respecting the affiliation of symbols. It is not surprising that the Hindoos

and Egyptians should both have adopted as the symbol of the sun the lotus-flower, which opens its petals to the dawn and infolds them on the approach of night, and which seems to be born of itself on the surface of the still waters. But the hypothesis of a borrowing becomes much more probable when, in the iconography of both peoples, we see the flower at once serving as a support to the solar gods—as Horus or Vishnu—and figuring in the hands of the goddesses associated with those gods—Hathor or Lakshmi, the Venuses of Egypt and India. The probability at last changes into a half-certainty when we find the lotus employed on both sides to render the same shade of thought in the rather indirect applications of solar symbolism. With either, the plant represents less the sun itself than the solar matrix, the mysterious sanctuary to which the sun retires every night to draw from it a new life.

We do not know and shall probably never know how the first communications of ideas were made between Egypt and India. But we can, by comparing monuments, discover some of the intermediate steps of the route which the symbolism of the lotus followed toward the East. Thus, in the sculptures of Phœnicia we find goddesses holding lotus-cups in their hands, and in the Persian bas-relief of Tak-i-Bustan the solar god Mithra is seated on the opened flower of the plant. Among the Mesopotamians and the Persians it is not rare to see this flower adorning tall trees, in which it is easy to recognize the sacred tree of the Semites or the Iranian tree that secretes the liquor of immortality. On a *patera* of Phœnician workmanship, found at Anathontis, the flowers of the lotus, borne by these conventional trees, are gathered in one hand by persons clothed in the Assyrian style, holding a key of life in the other hand. While the rosy lotus of the Egyptian monuments does not now grow wild anywhere in the valley of the Nile, it is, by a curious coincidence, preserved in the flora as well as in the symbolism of India.

One of the most frequent forms of the cross is called the gamma cross, because its four arms are bent at a right angle so as to form a figure like that of four Greek gammas turned in the same direction and joined at the base. We meet it among all the peoples of the Old World, from Japan to Iceland, and it is found in the two Americas. There is nothing to prevent us from supposing that in the first instance it was spontaneously conceived everywhere, like the equilateral crosses, circles, triangles, chevrons, and other geometrical ornaments so frequent in primitive decoration. But when we see it, at least among the peoples of the Old Continent, invariably passing for a talisman, appearing in the funeral scenes or on the tombstones of Greece, Scandinavia, Numidia, and Thibet, and adorning the breasts of divine personages—of Apollo and Buddha—without forgetting certain representations of the

Good Shepherd in the Catacombs, we can not escape the conviction that, in significance if not in form, it proceeds from a single source. This assertion seems to be confirmed in the class of monuments in which it is met. It appears, in fact, from prehistoric times among the people originating in the basin of the Danube, who colonized on either hand the shores of the Tread and of northern Italy; thence it extends, with the products of that ancient civilization, on one side to the Greeks, Etruscans, Latins, Gauls, Germans, Bretons, and Scandinavians, and on the other side to Asia Minor, the Caucasus, Persia, India, and finally to China and Japan.

It is not always necessary, for two figures to have the same origin, that they should have the same primitive signification. Sometimes it happens that a symbol changes its meaning in changing its country. It may possibly preserve only a general value as a talisman or amulet, like those crucifixes, degraded into fetiches, which are the only vestiges of the Christianity left among certain tribes of the Congo by the Portuguese domination of the last century. Sometimes, again—especially in the case of an image proper—its new possessors will seek to explain it to themselves by some more or less ingenious interpretation, and will thus restore to it a symbolical bearing, although by means of a new conception. The rising sun has often been compared to a newborn child. The comparison led the Egyptians to represent Horus as a child sucking its finger. The Greeks fancied that he was putting his finger to his lips to admonish the initiated to be discreet, and made of the representation a figure of Harpocrates, the god of silence.

Such changes of sense may also be reconciled with knowledge of the primitive significance. It is a pleasant thing to find everywhere the image or idea we are fond of. The Neo-Platonists believed in good faith that they could distinguish representations of their own doctrines in the symbols as well as in the myths of all the contemporary religions. The early Christians saw a cross in every figure that presented an intersection of lines—in the anchor, the mast and its yard, the standard, the plow, the man swimming, the bird flying, the praying man with outstretched arms, the paschal lamb on the spit, and the human face, where the line of the nose is crossed by that of the eyes. When the Serapeum at Alexandria was demolished, the Christian authors of the time related that a number of ansated crosses were found. They themselves observed that the figures were the same as the ancient Egyptian symbol of life, but that did not keep them from seeing in them a prophetic allusion to the sign of the redemption. Sozomenus adds that the fact provoked numerous conversions among the pagans.

It may also happen that the significance of a foreign symbol is knowingly modified, in order to adapt it to an idea or a faith previously destitute of all material expression or restricted to a few rudimentary representations. When the Persians had possessed themselves of Mesopotamia, they appropriated to themselves nearly all the imagery of the conquerors, in order to give form to their own religious conceptions, which the absence of a national art had left without any well-defined plastic representations. So, when the Christians began to reproduce on the walls of the Catacombs the scenes of the Old Testament and the parables of the New, they borrowed their primary models from classical and mythological art. Mercury Criophorus furnished the type of the Good Shepherd. Orpheus taming the wild beasts became a symbol of Christ and his preaching. The Christian holding to a cross to overcome temptation was represented by Ulysses tied to the mast of his ship, in order to resist the songs of the sirens. By an ingenious application of a myth which paganism has already spiritualized, Psyche offered the figure of a human soul to Love, whose place was taken by an angel. The religions of Gaul and India furnished examples of like assimilations from the time they came in contact with the symbolism of more advanced nations.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

CAN THE MOSQUITO PEST BE MITIGATED?*

THE annoyances caused by flies and mosquitoes have invited the special attention of Dr. Robert H. Lamborn, and prompted him to efforts to secure such study of their life histories and of their natural enemies as might lead to the discovery of some practicable means of mitigating their depredations. In 1889 he addressed a circular letter to the working entomologists of the country, offering prizes for essays containing original investigations regarding methods of destroying these pests. He had especially in view the utilization of the dragon-fly—a harmless insect, but at the same time exceedingly voracious and very fond of mosquitoes—and the possibility of propagating it artificially in places where mosquitoes abound. The results of the correspondence he had on the subject are published in this interesting book of studies, which, while it fails to verify the hopes which Dr. Lamborn entertained respecting the dragon-flies, does not fail but is encouragingly successful in pointing out some methods of considerable

* Dragon-Flies *vs.* Mosquitoes. Studies in the Life History of Irritating Insects, their Natural Enemies and Artificial Checks. By Working Entomologists. With an Introduction by Robert H. Lamborn, Ph. D. New York: D. Appleton & Co., 1890.

probable efficiency for reducing the numbers of the hosts of these enemies of mankind. The prizes were awarded by a committee consisting of Drs. H. C. McCook and J. S. Newberry—the first prize to Mrs. Eugene Aaron, of Philadelphia, for an essay on The Dipterous Enemies of Man; and the second prize equally divided between Messrs. Archibald C. Weeks and William Beutenmuller, of New York, for papers on The Utility of Dragon-Flies as Destroyers of Mosquitoes and on the Destruction of the Mosquito. These, with other contributed papers, are embodied in the volume. From Mrs. Aaron's essay we learn that the *Culicidæ*, or mosquitoes, breed in stagnant water, and have been observed living, in all stages of growth, in the most insignificant puddles—as "in a puddle of water, eight inches square and one inch deep, made by the rain in an iron pulley in a foundry-yard. They are also to be observed teeming to overcrowding in the hoof-holes in boggy cow-pastures. But the shallows occasionally overflowed and replenished by rivulets in swamps, the stagnant pools formed by ditches without outlets, and the vastly more numerous murky pools made by the joining of tufts of grass in marshes, are the usual breeding-places in the rural districts. In village and urban localities rain-tanks, undrained gutters, badly paved, damp byways, and garden ditches are the most fruitful places for recruiting their numbers. These surroundings are selected by the female with a view to the fact that from three to four weeks will be required to perfect the changes from the egg to the imago; and they must be situated so as to receive sufficient water from rain or outside overflow to replenish the evaporation or soaking into the ground. In this selection the female shows the usual instinct which is so noticeable in insect economies." When hatched, they hug the sides of pools and shallow margins, and, spending most of the time at the surface with the orifice of the air-tube just in contact with the air, are not usually found at great depths. They are easily frightened by any stir or motion from above, but pay little attention to any dangers that may menace them from the water. Very little is known of their feeding habits; but the statement that they are scavengers, feeding on decaying substances in stagnant water, has not been confirmed or disproved. They have been observed to feed on minute animals, and to destroy young trout. They go through several transformations, and reach a curious shape in the pupa, which—the head, thorax, legs, and wings, all being folded in one mass, and the abdominal segments being left free for the purpose of navigation—has a top-heavy and clumsy appearance, although it is quite as active as the larva. After the insect has matured and has begun its flight, the principal objects in its remaining brief existence "are the search for the desired mate and the duties of

reproduction. To suppose that the tormenting of man occupies any considerable time in the mosquito economy is certainly a mistake. It is only the female which can thus make our lives miserable." They are local in their range, and the supposition that they can be carried long distances by the wind is declared a mistake. House-flies are omnipresent with us, while mosquitoes appear only in spots. According to Packard, "fresh horse-manure, with plenty of heat and moisture, furnishes the best food for the young maggot. From a hundred to a hundred and fifty eggs are deposited in irregular, loose sacs, usually within eighteen hours, and hatching in twenty-four hours or less. The maggots molt twice; the three stages of larval development being of the following periods: first stage, one day; second stage, from twenty-four to thirty-six hours; third stage, three or four days. To this maximum period of seven days is to be added the same length of time for the pupal life; thus it will be seen that fifteen or sixteen days are required for the entire development from egg to imago."

The expediency of trying to exterminate them is more than doubtful, for, according to the same author, "it should be remembered that flies have an infancy as maggots, and the loathsome life they lead as scavengers cleanses and purifies the August air, and lowers the death-rate of our cities and towns. Thus the young of the house-fly, the flesh-fly, and the blow-fly, with their thousand allies, are doing something toward purifying the pestilential air and averting the summer brood of cholera, diphtheria, and typhoid fevers which descend like harpies upon the towns and cities. It is a useful species, to which man owes more than he can readily estimate, and with which he can dispense only when the health of our cities and towns is looked after with greater vigilance and intelligence than is perhaps likely to be the case for several centuries to come."

Mosquitoes, therefore, are entitled to exclusive attention in the exterminating effort.

Mrs. Aaron has a poor opinion of the efficiency of the dragon-flies, or *Odonats*, as mosquito-destroyers. They become rarer about the time that the mosquitoes are most numerous. In the matter of flight they are very local, and it seems impossible to conceive that they could ever be brought to frequent deep woods or city streets where mosquitoes abound. The author's observations of their feeding habits lead her to believe that they prefer robust, meaty insects, and that studies of their appetites in confinement are misleading. The habit of migration among them will also militate against their efficiency as mosquito-destroyers.

Other writers find that they are capable, in natural conditions, of working great havoc among mosquitoes, but doubt the utility of efforts to improve on nature in the matter. Captain C. B. N.

Macauley, U. S. Army, relates that, in a mosquito-infested region of Montana, he was told how the mosquitoes had disappeared, as if by magic, on the sudden appearance of a brood of devil's-darning-needles or dragon-flies of rather large size. The agency of this insect in the matter was corroborated by the evidence of squaw-men and Indian traders, who said that the flies did not appear every mosquito year, but, when they did, they came in droves and cleared the mosquitoes out. They were called "mosquito-hawks." The captain himself afterward had an opportunity of observing them at work, and to determine that they were dragon-flies. "I noticed," he says, "that they flew in an irregular kind of skirmish-line, moved slowly, and every now and then made what he described as short 'dabs' at apparently nothing. Mr. Heistand said that 'each one of these dabs means a mosquito.' I was curious to see how deliberate they were about it, and how fairly aligned the skirmish-line was. They appeared somewhere about 11 A. M., and when I went into the post later I crossed the parade-ground and saw detachments of about half a dozen flying slowly about. They stayed at about an average of three feet from the ground. I do not know how late they kept it up or how early they began. They stayed until all the mosquitoes appeared to be gone." Dr. Lamborn also tells how his own attention was drawn to the subject. It was while he was in the forests of Lake Superior, railroad-building. "Sitting in camp while supper was being prepared, I often, with a sentiment of gratitude, looked through my mosquito-veil at the dragon-flies that collected in the open spaces among the pine-trees. They darted from side to side like swallows in a meadow, but with amazing rapidity, and at every turn, the natives assured me, 'a mosquito ceased from troubling.' Afterward I happened to observe an entomologist feeding a dragon-fly that had eaten thirty house-flies in rapid succession without lessening his voracity. What thought could be more natural than the one that came to me, that an artificial multiplication of dragon-flies might accomplish a mitigation of the mosquito pest?"

Mr. Beutenmuller, of the Museum of Natural History, New York, avers that "the dragon-flies (*Odonata*), especially the *Æschinus, Gomphina*, and *Libellulina*, are the natural enemies of the mosquitoes; they are voracious—they sometimes appear in great numbers, and, as a matter of fact, the mosquito disappears before them, while their breeding-grounds are, in many respects, similar, so far as fresh and brackish water habitats are concerned; and, finally, in the metamorphosis of the dragon-fly we meet conditions which introduce it in antagonism to the mosquito at the same stages of development." The dragon-fly, however, prefers sunlit areas, and will not live in the woods.

These are the conditions in nature. But the attempts to subject dragon-fly life to the rules of art do not appear to have been successful. Mr. Weeks tried earnestly and most intelligently to raise the insects artificially on his father's farm on Long Island and in his house in Brooklyn, and failed to obtain any results worth boasting about. He finds that they are diurnal, working in the sun, and never present at night, when the mosquitoes are busiest; that they are short-lived, and frequently destroyed in large numbers by heavy showers and winds; that, with few exceptions, they confine themselves to the vicinity of their place of birth, and, if removed therefrom, quickly return—hence, can not be colonized; and he concludes that "an attempt to destroy flies and mosquitoes by the artificial propagation of dragon-flies or any other insect would be unprofitable, unadvisable, and impracticable."

Mr. Beutenmuller thinks that positive statements can not yet be made respecting the expediency of artificially breeding dragon-flies for use against the mosquito. Differences in the habits of the two insects are against the scheme. Dragon-flies seek open places and the sun, while the mosquito finds hiding-places in the woods and in tall grass. "Under these circumstances the dragon-fly will not find its prey. Great numbers will escape; only those encountered in its busy flight through the air will be captured, for the dragon-fly does not hunt for its booty nor scour the forbidden shadows of woods and forests, and at nightfall the mosquito will elude his pursuer and rise to his murderous intent." But the dragon-fly "may, in some genial locations, suit the elements of the question and be of practical service; it may, indeed, be more widely beneficial than we suspect."

Of other means of keeping down mosquitoes, Mrs. Aaron recommends flushing the breeding-places with water, draining swamps, creating active artificial currents, encouraging fish, and spraying their hiding-places with petroleum. Mr. Weeks has faith in the enforcement and observance of sanitary laws and the encouragement of birds. Mr. Beutenmuller advises the use of lanterns so arranged as to attract and destroy the mosquitoes, with pans of kerosene or other strong mixtures for their destruction, which may be placed around houses and hotels and in marshes, general and scientific drainage of swamps; encouragement of fish and waterfowl; and, where the conditions are favorable, the use of coal-oil in the waters of estuaries of rivers and on the rain-invaded areas of deep woods for destruction in the larval stages. Astringents, like logwood or alum, will also prevent the growth of the mosquito in its incipient stages. Dr. H. C. McCook thinks it might be well to call spiders into service.

The most generally effective of these remedies seem apparently to the authors in the book to be petroleum spraying and draining. A very little petroleum, spreading itself in a minute film over the water surface, will go a great way in destroying the larvæ. Drainage also promises to be very efficient. "It goes even farther back than the larval stage, for it precludes the incipient acts of the mosquito at propagation. It robs her of the congenial *nidus* for the development of her eggs." The question can, however, only be satisfactorily settled by a concerted movement over wide tracts of land. "The arrest of the plague in one portion of the country when the next section makes no effort to suppress its own contingent can only lead to discouragement and ridicule." Against the house-fly the most promising measure of offense is the encouragement of the fungus that destroys it, which is identical with the yeast-plant; but, as flies seem to do as much good as harm, it will probably be wisest to leave them alone.

SLAVONIAN FAIRIES.

By Dr. FRIEDRICH S. KRAUS.

IN my studies in South-Slavic folk-lore, I have frequently come in contact with the Vila superstition, but only recently under conditions in which I could make a full investigation of it. The native literature on the subject is immense, but so confused and indefinite that an adequate examination of it would constitute a very serious task. The only way to obtain a satisfactory degree of knowledge in the matter seemed to be to sojourn at places where the population was relatively pure, and become acquainted with the living beliefs of the people. This I have done, having resided at five places, and searched out their popular traditions as one would suck an orange. Especially with regard to the Vilas have I got enough to make a book; I shall here give only a short chapter from it, including a part of what I learned in the single village of Pleternica. This village lies at the foot of a mountain on the right bank of the Orliava River, about three hours from Brod on the Bosnian frontier. The present village is not more than one hundred and thirty years old. In it the estates lie scattered among the hills, each on an elevation by itself, and each a fortified post. The people are engaged in farming, herding, and robbery. The practice of robbery is an inheritance from Turkish times. A large part of the population, who had been Mohammedan, had embraced Roman Catholicism in order to keep their property. Some of the families still boast their Mohammedan extraction. Many Catholics have recently come into the

place from Bosnia, and it has about fifteen hundred inhabitants. The people can all read and write, are neat, enterprising, industrious, and well off; but, notwithstanding their good schools, they stick to their old, pre-Christian superstitions.

The Vilas, which occupy the greatest space in the popular lore, are female beings of the same kind as the fairies or wood-nymphs of the Germanic nations. The etymology of the name is uncertain, but it is supposed to mean "rustic"; and the Vilas are therefore spirits of the wood. The belief in them controls all the incidents of the peasant's life. The spirits are supposed to appear rarely alone, but usually in companies of two, three, five, or seven. They are distinguished by an extraordinary, maidenly beauty, clear complexion, slender stature, and dark, wavy hair descending to the ankles. They move lightly and freely through the air, being winged, although their wings are usually invisible. They can also lay their wings aside. Their dress is simple, and includes a crown of pearls on the head inclasping the floating hair; a long white robe, such as is worn by the peasant women at their work, reaching to the ground, without any outer garment; and a girdle of red silk.

They enjoy everlasting youth, are acquainted with divination and healing, have access to all the treasures of the earth, and can at will produce love or hatred in the children of men. They are particularly friendly to deer, horses, sheep, and godly men. They can assume the form of the gray mountain wolf. Under some circumstances they are pettish, evil, and vengeful; they teach children to steal; but sometimes, out of pity, take forlorn orphans under their care. They prefer to live upon or in trees, especially favoring the linden and nut trees; travel in the clouds or in whirlwinds; dance on hillocks, in green fields at springs, on roofs, and under isolated trees, accompanying the exercise with songs, and are distinguished by a clear, penetrating cry.

Their ordinary occupations are milking does, combing their hair with golden combs, washing their robes, and bathing in clear streams under the shadows of the overhanging trees. If a person wants to see Vilas or enjoy their presence, he must, if he is not gifted with the second-sight, put on his clothes wrong-side out. Children born on Tuesday or Sunday have the second-sight; but the Vilas never show themselves to children born on Friday or to red-haired men. Really faithful and Vila-fearing men carefully avoid speaking their name. They say "she," "that one," or, in case of more than one—two, for example—"those two."

The Vilas are supposed to be voluptuous creatures, and to lead lives that would not be regarded, according to our views, as moral. They bear only female children, which take after the mother. Whoever has enjoyed their favors can never afterward love a

mortal woman. But one can rarely count on the endurance of their love, or be happy with it, and at last the chosen one will try to escape them. They are also sometimes accustomed to take men into their society; but one who has once associated with them, willingly or unwillingly, can never get rid of them, and must at last pay for his mistake with his life. He is strangled or torn to pieces, or, if a lighter punishment is administered, he is made blind or lame. The Vilas are able to call back to life men that they have slain, and also to lift the disabilities they may have inflicted upon any one. If a man succeeds in robbing a Vila of her wings, he acquires full power over her. If she loses her crown and her robe, she only suffers a separation of some time from the society of her playmates.

Three stories that were told me give some insight into the customs of the Vilas. As the peasant Adam Odvorcie was driving along, he came to a hill where seven Vilas were dancing. As he drove by, they came down and frightened the horses so that they ran away, leaving him in the road. He waited till the Vilas went away. A little farther along he saw seven of them washing their clothes. Reza Barjanovie relates that, in the summer of 1887, as she was sitting under a nut-tree in the yard with her mother-in-law, they heard dancing and singing on the hill back of the house. All at once there arose a whirlwind and drove through the yard, striking them forcibly. They were much frightened, and, while trying to consult as to what had best be done, the mother-in-law, accidentally looking up at the roof, exclaimed: "Look! there are Vilas up there!" She said again to Theresa: "Look, daughter! the Vilas are dancing on our roof!" At that moment the Vilas disappeared. Both women have the second-sight. They often go to the woods in the morning and have opportunities to see much that is uncanny.

Koprivce Vic, an octogenarian of Pleternica, wrote me on the 25th of April, 1887, in his own handwriting, of the following adventure he had had with the Vilas: "Several years ago, in the old times, I was going into the mountains with my grandfather. It was late in the fall, and I was helping him drive the oxen through the plum orchard to the pasture. We perceived *them* away off, stamping with stamps, washing *their* robes. The nearer we came to *them* the more distinct grew the stamping. We were about to turn back, but took heart and went to within a few yards of *them*. Two of *them* were washing robes. We saluted *them* in the name of God. *The two* rose, threw their stamps over their backs, and let their hair fall to the ground. When we had gone a little farther, one said to the other, 'What shall we do to them?' Said the other, 'Nothing, for they saluted us in the name of God, and we shall have to let them go.' Upon this we

returned to the orchard and lay down under a plum-tree. Grandfather fell into a sleep, and *it* took him by the hair and began to beat his head against the tree. We jumped up forthwith and ran into the cellar."

The truest and firmest friendships for mutual help in peace or suffering are concluded among the South-Slavic peasantry by the confirmation of an elect brotherhood or sisterhood. Obviously a connection of that kind with such powerful beings as the Vilas must be considered exceedingly precious. In the *sagas* and heroic songs of the people every great champion has a sworn sister among them. How such privileges are obtained was as unknown to me as to every other writer on the subject, for the people, if they know, will not willingly give up such a secret to every questioner; but Mother Eve, of Pleternica, who keeps all these traditions of the past living in her mind down to the present day, told it all to me. The fact that it is so fresh in her recollection is evidence that the cult still exists. The time of the telling was February 28, 1888.

If a person wishes to contract this relationship, he must take a horse's hoof, a piece of skin cut from under the hoof, and two or three hairs from the mane, the tail, and the head of the horse. He must also take a new broom that has never been swept with, and the price of which he has not beaten down in buying, and must provide himself with some horse-dung. Then, on the first Sunday in the new moon, he must go into the yard, sweep a circle around himself, and in the middle of the circle put the hoof and the other things he has taken from the horse, and, standing with the right foot on the hoof, with both hands brought together by the palms, call three times between the hands, three times turn around with the hoof, and utter the formula: "Sister Vila! I seek you over nine fields, nine meadows, nine brooks, nine woods, nine hills, nine mountain-peaks, nine ruined towers! Come to me and let me swear brotherhood with you!"

When the Vila appears, the person performing the conjuration says: "Sister Vila! I have found you now, and am your chosen brother!"

The conjuring person again blows three times through his closed hands and continues: "Sister Vila! give me your help whenever I call upon you, and help those whom I would help."

He must next name the person whom he holds dearest in life: if a man, the maiden of his choice; if a woman, the man. After which he adds: "Sister Vila! I conjure you by the living God and the sister Vilas that I may have what is mine from the beginning of the world." The rising sun is meant by "the living God."

By contracting this relationship one may assure himself of

the assistance of the Vilas, and may also become more or less of their kind and acquire various arts from them. Men thus sometimes obtain the mystic power of changing themselves at pleasure into an animal, as a horse or a wolf, and of doing much mischief. Wizards and medical practitioners, men and women, boast of their relationship and ascribe their skill to it. A dwarfish herdsman, about forty years old, living in a cave in Odvorci, is distinguished as a cheiromancist, and can tell from the lines of the hand what herbs are good for a patient. He asserts that the Vilas had him under instruction for seven years. A *Bracara* lives at Petersdorf, to whom suffering Mohammedans come from Bosnia and pay two golden ducats for a cure. He gets such prices because he professes to be able in serious cases to hold consultations with the Vilas.

Toma Miemkovic, of Pleternica, told me the following story of a woman changing into a wolf, vouching for its truth, because, as he pretended, he had himself seen the person in question. There lived a very rich man at Trapari, who possessed a great flock of sheep, over which he put two shepherds and six dogs. Every day a wolf appeared, ate up a sheep, and vanished, without any one being able to see it. The overseer raged, and the sheep kept disappearing till three fourths of them were gone. At last he became desperate, when he was told by some one that there was no real wolf, and was advised to get up early in the morning, put on all his clothes, from his shoes to his cap, wrong-side out, drive the sheep to the brook in the pasture, climb a tree and wait; by means of which he would be able to find out who the wolf was. He followed this counsel. About noon an old woman of the neighborhood came down with a pail on her head and drew water from the brook. Then she lay on the grass, turned three somersaults, changed into a wolf, seized the fattest wether—a four-year-old—and ate him, wool, entrails, hoofs, and all. The man was on the point of shooting her from the tree, but, as he knew her, thought it better to punish her well at home. After the wolf had eaten the sheep, it executed three more somersaults and turned back into the old woman. The overseer came down from the tree and chastised her well; and, when her sons heard what she had been doing, they cudgeled her so thoroughly that she could hardly bear to have anything touch her. From that time on she never changed into a wolf, or ate any more strange sheep.

The womanly nature of the Vilas appears in their insatiable revenge for scorn of their love. The following story corresponds with the legend of the youth who knew no fear. The outcome in the present case is the discomfiture of the rash man; for, instead of the usual ghost, Vilas appear as the spirits of revenge.

There was once a Magyar who was so handsome that one could

hardly admire him enough. The Vilas took him away and taught him for twelve years to dance, but he would not and could not learn. On the first day of the thirteenth year, about eleven o'clock in the morning, he escaped from them, took refuge in a wood, and hid in a large, hollow oak-tree. About eleven o'clock at night the Vilas came up to him like clouds, and tried to get him away. They called to him: "Come, love, to us; don't be afraid." But he would not answer. At daybreak he started again on his road, and came to a pasture where some herdsmen were watching swine. He asked them to protect him. They gave him something to eat and drink. He lay down, and they posted themselves in a circle around him. The Vilas came again about midnight and asked him to go with them, but he refused. In the morning he paid the herdsmen well for their care, went on, came to an inn, and asked for a lodging. The landlord answered that he could not accommodate him, for he had only one chamber, which no one dared to sleep in, for whoever spent a night in it never lived to see another day. The Magyar replied: "I am not afraid; only give me enough smoking-tobacco, candles, a table, a chair, and a bundle of kindling-wood. You need not trouble yourself about me." He lit the candles, sat down, and went to smoking. The Vilas came about ten o'clock, alarming the whole house, and cried to him, "Ah, now we have caught you!" and they carried him off and made a male Vila of him.

The dances, to which persons allied by sworn brotherhood are admitted, take place in the night-time. The participants must not talk of the matter, under penalty of death. The Podborje Hill, at the baths of Daruvar, at the foot of which is a church of the old believers, was recognized some thirty years ago as a place where such dances were held.

A young woman of fifteen, in Drenovci, was accustomed to go out every night, as soon as her husband was asleep, and soar around with the Vilas. On one of these occasions the husband awoke, and, not finding his wife at his side, remained awake till she came back at dawn. In the morning he asked her if she had slept well. She said no, she had had a restless night. The next evening she went out again with the Vilas. The husband lay awake, and on her return at dawn asked her where she had been. She made no answer, but was found dead in the morning.

Whatever once comes into the possession of the Vilas is lost to men; and if a man gives an unsuitable thing to them, he will have to suffer for it. A peasant girl told my mother that, when her little Catherine was fretful and could not sleep, she took her in the evening, when the cattle were coming home, into the front yard, gave her a swing, and said, "God and the Virgin help us. The Vila marries their son and invites Catherine to the wedding.

Catherine can not go, but sends her moaning there"; and the child would cease to fret.

The Vilas play a subordinate part in many other stories, and occasionally appear mixed up with religious ideas in such a way that a course of comparative studies would be necessary to make them clear.—*Translated for the Popular Science Monthly from Das Ausland.*

SKETCH OF THOMAS CORWIN MENDENHALL.

By GEORGE ILES.

AMERICA is rich in men who have proved how much more decisive in a career of usefulness is nature than nurture, the instinct for acquiring knowledge than facilities for instruction, a worthy ambition to render service to one's fellows than all the means and agencies which wait upon circumstances ordinarily and often ignorantly called favorable. Such a man is the subject of this sketch.

THOMAS CORWIN MENDENHALL was born on October 4, 1841, near Hanoverton, Ohio. On his father's side he is of Quaker stock, tracing his descent from Benjamin Mendenhall, who emigrated from Wiltshire, England, with William Penn, and settled in Delaware County, Pennsylvania. Young Mendenhall's schooling was of the scanty kind afforded by small country villages more than a generation ago; defective though it was, it developed in him at an early age a fondness for the study of mathematics and the natural sciences. He gradually won for himself an education which his opportunities would have denied to a less sturdy spirit.

Among the most important influences working for his mental development in boyhood was the encouragement of his father, who, while he had enjoyed only limited opportunities for educational training, was an earnest, thoughtful man, and fond of reading. From him, along with the conviction that there must be an antecedent cause for every effect, he derived a disposition to investigate causes and inquire after reasons. Another impulse, which must have had a very considerable effect upon the determination of his future career, was given him by one of his teachers in the old log school-house—a good Quaker lady, who had a way of setting her pupils to making simple experiments, and thus, as he has said to us, directed the first physical laboratory that he ever entered. She taught him that a ray of light was bent in passing from one medium to another of different density, by means of the old and familiar experiment with the coin and tin cup. On another occasion, by darkening the windows, except for a small opening in the

corner of one of them, with the shawls of the girls, she showed how an image of the big boys jumping from a "spring-board" outside was projected on the roughly plastered ceiling. Such experiments and illustrations made a great impression on him, as they undoubtedly did on his fellow-students, and, we may assume, produced lasting influences that varied in each according to the bent of his mind. Young Mendenhall read also with great eagerness the small volume of Comstock's Natural Philosophy which fell into his hands about this time, and was allowed to draw the cuts of levers, pulleys, etc., on the blackboard at school. He experimented on the law of the lever when, with the other boy who had been detailed with him for the duty, bringing water from a distant spring to the school-house, the pail was carried between the two on a stick. He had a taste for mechanical operations and was something of an inventor, and was especially fond of mathematical studies. Of the few books in the small family library Chambers's Information for the People was his favorite, and he read and reread it till he nearly knew it by heart. In astronomy he made his first observation by means of a semicircle of wood which he had roughly graduated and mounted in the meridian, and on which the line of collimation was determined by two pins at the extremities of the diameter. When about eleven years old he made an unsuccessful trial of Foucault's experiment to prove the rotation of the earth, of which he had read in a newspaper. When it became necessary for him, at an early age, to care for himself, he continued his studies at odd times as he found opportunity, still attending school as regularly as he could. Rainy days on the farm were eagerly made use of for reading and study. Studies in algebra were carried on while he was employed in a saw-mill, and the problems were worked out on loose boards with chalk. "More than to all other sources, however," Prof. Mendenhall remarked, "I am indebted to the friendly advice, encouragement, and assistance of teachers and others with whom I came in contact. To be made to think that I could do something or had done something by a word of kindness or congratulation was to be helped along immensely."

Remembering the waste of time, the discouraging, because useless, difficulties of his youthful struggle, Prof. Mendenhall has ever been a faithful advocate of bringing the highest education and the best scientific culture within the reach of every seeker of it. His proficiency in science soon developed itself in the perfect form needful to one who would successfully teach. In 1873, on the organization of the Ohio State University, he was elected to the chair of Physics and Mechanics, which he held until 1878, when he accepted the professorship of Physics in the Imperial University of Japan at Tokio. While in Japan he organized a

special course in physics, and established a physical laboratory in connection with the science department of the university. In addition he founded a meteorological observatory, which after his departure was merged into the general meteorological system established by the Japanese Government. Prof. Mendenhall furthermore carried out an investigation on the force of gravity at the sea-level and on the famous Japanese extinct volcano Fujinoyama. His measurements of the figure of the mountain and of its density enabled him to deduce a value for the mass of the earth which agrees very closely with that of Francis Baily as obtained by the Cavendish method. About this time he also made a series of elaborate measurements of the wave-lengths of the principal Fraunhofer lines of the solar spectrum by means of a large spectrometer, then one of the best in existence. This work was done before Prof. Henry A. Rowland had produced his famous diffraction gratings, but some fine specimens of Lewis M. Rutherfurd's rulings were used. No precise measurements of these rulings were undertaken; hence Prof. Mendenhall's results were only valuable as ascertaining the relative spaces of the various portions of the spectrum; as such they rank among the best given to the world previous to the recent researches with gratings of accurately known and more minute division.

Japan is a land of frequent earthquakes, and Prof. Mendenhall soon became interested in studying their phenomena. That this study on his part and that of others might be systematic and co-operative, he aided in founding the Seismological Society of Tokio. While ardent in his university work and an unsparing toiler in diverse fields of original investigation, Prof. Mendenhall felt that he had a duty to men and women who could not enter his classes nor read the scientific memoirs he was writing. With Prof. Edward S. Morse, then in Japan, and others, he gave lectures on scientific themes to popular audiences in the temples and theatres of Tokio. So thoroughly was an intelligent curiosity thus aroused in the city, that soon a public lecture hall was established—the first in the Japanese Empire.

In 1881 Prof. Mendenhall returned to the United States and resumed his chair at the Ohio State University. In the following year he organized the Ohio State Weather Service, of which he was director until 1884. While holding this office he devised and put into operation a system of weather-signals for display upon railway trains. This system was generally adopted throughout the United States and Canada; in 1887 it was superseded by a new code introduced by the Chief Signal Officer. In the United States Signal Service at Washington Prof. Mendenhall received an appointment in 1884. Here he organized and equipped a physical laboratory in connection with the office of the Chief Signal Officer,

and inaugurated systematic observations of atmospheric electricity. One of the results of his work was proof that rain precipitation is the cause rather than the effect of electrical discharges in the atmosphere. He concurrently investigated the methods for ascertaining ground temperatures, inventing improved forms of apparatus. Pursuing a line of inquiry begun in Japan, he established the systematic gathering of data regarding earthquakes from stations scattered throughout the United States. Immediately after the earthquake of August 31, 1886, he visited Charleston, and made a report upon the agitation with a co-seismic chart showing the disturbed area. It seems probable that, before many years elapse, the phenomena of earthquakes will have sufficiently yielded their secrets to enable predictions of their occurrence to be made, following up and perfecting the methods by which the Weather Bureau now issues its forecasts. In this branch of science, as important as it is difficult, Prof. Mendenhall has done invaluable work as a pioneer. After two years' service of the Government, he resigned, to accept the presidency of the Rose Polytechnic Institute in Terre Haute, Indiana. His new responsibilities were discharged with marked success; he brought to them rare address, tact, and executive ability. The Institute, young as it was, soon had an assured place among the leading technical schools of the country. That it supplies an educational need in the flourishing city in which generosity has placed it came out plainly at its commencement exercises last year. On that occasion Prof. Mendenhall was able to say that every member of the graduating class had secured an engagement and was fairly launched upon his life-work.

In July, 1880, Prof. Mendenhall was nominated by the President to fill the superintendency of the United States Coast and Geodetic Survey, one of the most important scientific appointments in the country, and which has been held by men of the stamp of Alexander Dallas Bache, Benjamin Peirce, and Julius E. Hilgard. Prof. Mendenhall succeeds to their fame, but also to administrative duties which have grown more onerous with every year of the survey's history. He has nevertheless an opportunity for scientific work which his energetic and organizing mind is not likely to leave unimproved. His interest in the gravitation work which the survey has carried on for several years has led to the formation of new plans for its more rapid and vigorous prosecution. For some time past the survey has been engaged in the study of terrestrial magnetism; its researches in this direction are being actively pressed forward, one aim being to locate the north magnetic pole with precision. In geodesy the survey is steadily advancing the great transcontinental system of triangulation, and some new contributions of importance toward our knowledge of

the earth's figure are likely to be presented at an early day. As Superintendent of Weights and Measures, Prof. Mendenhall enters upon another field of duty for which his work in the past has been a preparation. He has long borne a prominent part among the teachers who have pressed and still continue to press the metric system upon the American public. He is an active member of the American Metrological Society, and has repeatedly, on the platform and through the press, taken occasion to impeach the current irrational medley of pounds avoirdupois and troy; of grains, gallons, feet, and bushels.

Prof. Mendenhall has uncommon gifts as a lecturer; his masterly expositions of physical themes continue to be given despite the pressure of official duties. At the Cooper Institute in New York, the Lowell Institute in Boston, the Peabody Institute in Baltimore, the Mechanics' Institute in Cincinnati, the Brooklyn Institute, and in other of the chief popular lyceums of the country, he has been greeted by large audiences. The honorary degree of Ph. D. was conferred on him by the Ohio State University in 1878, and that of LL. D. by the University of Michigan in 1887. In the latter year he was chosen a member of the National Academy of Sciences. He was elected a member of the American Association for the Advancement of Science at the Indianapolis meeting in 1871, and was advanced to the grade of Fellow in 1874. In 1882, at the Montreal meeting, he presided over the Section of Physics. His address on that occasion was a forcible plea for physics in education, presenting a judicious view of the value of guidance when students attempt original research. In 1888 he was chosen President of the Association, and in that capacity at last year's meeting, in Toronto, won golden opinions on all hands. At the approaching meeting in Indianapolis he will, it is understood, take for the theme of his address, as retiring president, The Relation of Science and Scientific Men to the General Public.

In 1887 he contributed the first volume to The Riverside Science Series, A Century of Electricity. A revised and enlarged edition of this capital popular treatise has been issued this year. From among his numerous contributions to scientific publications we select: On the time required to communicate impressions to the sensorium and the reverse, American Journal of Science, 1871; On the heaping of liquids, American Journal of Science, 1873; An improvement on Bunsen's method for specific gravity of gases, Proceedings of the American Association for the Advancement of Science, 1878; Temperature and index of refraction, American Journal of Science, 1876; Co-efficient of expansion of a diffraction grating, American Journal of Science, 1881; Memoirs of the Scientific Department of the University of Tokio, Ja-

pan: (1) Report on the meteorology of Tokio, 1879; (2) Report on the meteorology of Tokio, 1880; (3) Measurement of the force of gravity at Tokio and the summit of Fujinoyama, 1881; (4) Wave-length of some of the principal lines of the solar spectrum, 1881; The influence of time on the change in resistance of carbon under pressure, American Journal of Science, 1882; Differential resistance thermometer, American Journal of Science, 1885; Report on the Flood Rock explosion, Science, October 1885; On the electrical resistance of soft carbon under pressure, American Journal of Science, 1886; On characteristic curves of composition, read at the American Association for the Advancement of Science meeting, 1886, published in Science, March 1887; Seismoscopes and seismological investigations, read at the meeting of the National Academy of Sciences, 1887, published in American Journal of Science, 1888; On an improved form of quadrant electrometer, read at the meeting of the National Academy of Sciences, 1888; On the intensity of earthquakes, with approximate calculations of the energy involved, Proceedings of the American Association for the Advancement of Science, 1888; On globular lightning, American Meteorological Journal, 1890. A memoir of researches in atmospheric electricity, read before the National Academy of Sciences in 1888, is now in course of publication.

In the attempt to measure the duration of a flash of lightning, Mr. A. C. Raynard, in Knowledge, regards a recurrent flash as "a very complicated succession of discharges lasting for an appreciable part of a second. The giant discharges which take place during a storm, between irregularly shaped and badly conducting masses, differ materially in character from the flashes produced in a laboratory between good conductors. In the laboratory the whole flow takes place at once. In nature there seems to be a flow or rush succeeded by a dribble, which ceases or nearly ceases, and commences again and again, flow after flow rushing down the same path until the potential along the line of discharge is realized." The appearance of "ribbon-flashes" in some of the photographs is supposed to be due to unsteadiness or imperfections in the instruments.

The present greater proportion than formerly existed of men who are active and vigorous after passing seventy years of age, and all the way even up to ninety, denotes one of the brighter phases of our civilization. The fact that such vigor is associated with different physical types, both suggests that there may be a general origin for it, and feeds the hope that it may partly depend on personal conduct. Dr. B. W. Richardson advises that the preparation to secure long life may begin with the training of children, by protecting them against mental disturbance as well as physical hardship; and may be carried out in more mature life by combining, with hygienic living, healthful activity of mind with lively interest in all things that make for good, while restraining or avoiding passion, undue excitements, and unlovely qualities.

EDITOR'S TABLE.

TARIFF LEGISLATION.

THE tariff question is one that will not down. So long as the government of any country interposes arbitrary obstacles to the activity of the people, so long as it undertakes to make artificial channels for industry, to open markets here and close them there, to dictate the prices at which goods shall be sold —so long, in a word, as it assumes the prerogatives of an all-wise Providence in directing the affairs of individuals and showing them how to be happy—so long will there be "a doleful song steaming up" of the ignorance, incapacity, and injustice that mark its action. We endeavored to show, a couple of months ago, that a policy of protection, as it is called, naturally and inevitably allies itself with fraud and extravagance in the Government, and we do not think the demonstration can easily be refuted. The essence of the protective system is that the Government or the Legislature undertakes to make higher prices for goods by shutting out competition from abroad. Is it to be supposed for one moment that the people for whom a favorable price is thus to be made will not give pecuniary support to the party that so arranges things for their benefit? Is it not perfectly known that election funds are provided in this way, and that the taxing power is thus virtually put up to sale? The crowning disgrace of the worst days of the Roman Empire was that the supreme power in the state was made a matter of bargain and sale with a corrupt soldiery. We are far removed from the days of the Roman Empire; but how far are we removed from its methods? The question is a serious one.

We publish in this number of the Monthly the conclusion of a carefully prepared article by Mr. Edward Atkinson bearing on this subject, the first part of which will be found in the August number—an article which we trust will receive the attention it merits. Take one statement that Mr. Atkinson makes—and he is a writer who is known to be careful about his facts: "On the plea that this branch of industry" (production of iron) "should be sustained, the consumers of iron and steel in this country have paid a sum in excess of the price paid by the consumers who have been supplied by Great Britain and Germany, ranging from $50,000,000 to $80,000,000 a year. The excess of price has not been turned over to the workmen by the owners of the mines and works." Not at all; the workmen have been left to compete as savagely as they chose with one another, and with a constant stream of new-comers; and the manufacturers, profiting thus by cheap labor, have been enabled to carve huge fortunes for themselves out of the excess in price secured to them by the Legislature. It is no wonder if want of gratitude for such big mercies struck Chairman Foster as a most hideous crime; but such ingratitude is the exception rather than the rule, and would chiefly manifest itself when the monopoly seemed secure against attack; a little danger would develop "barrels" of gratitude.

The misery is that we have a manufactured and altogether falsified public opinion on this subject—a public opinion, we fully believe, which has not attained its present consistency without much not altogether disinterested advocacy. What is the use of having the "sinews of war" if you do not employ them? Money speaks in more senses than one; the chamber of Danaë is not the only sanctum that has been violated by a shower of gold. Be this as it may, however, certain it is that the public at

large have very erroneous ideas as to the actual results of a protective policy. Most think that, in some mysterious way, protection confers a benefit upon all. It is notorious that in many "protected" occupations wages are at a minimum; it is certain that multitudes suffer from their enforced exclusion from foreign markets; and it is a conspicuous fact that private fortunes are on the increase both in number and in average amount: yet still the delusion is cherished that protection is making the nation, as a whole, richer and more prosperous. Mr. Atkinson says distinctly that "there is a vastly greater proportion of farmers and farm laborers whose home market depends upon the export trade than there is of those who might possibly be harmed if, through imports of foreign articles, the demand for their own products were reduced." He ridicules, and with good reason, the idea that Congress is fit to choose occupations for the people. "What an absurdity!" he exclaims. "As if the people were not bigger than any Congress that ever existed, and could not manage their own affairs vastly better than the average member." With all respect to our valued contributor, we do not think he strikes quite the right note here. There is no need to flatter the people at the expense of Congress, which, after all, is elected by the votes of the people, and contains just as much wisdom and patriotism as the people care to put into it. The point is not that the people are wiser on the average than Congress, for that is not certain; but that no individual is wise enough to undertake to interfere with the natural laws of supply and demand, or to substitute artificial adjustments of his own devising for those naturally existing in the economic sphere. We would not trust all the wisdom in the country to undertake such a task. There is this, too, to be considered: that each private individual feels for himself the pressure and influence of surrounding conditions upon his business, and adapts himself thereto as best he can; whereas the Legislature deals with business generally — the business of the whole country—upon more or less abstract principles. In this sense the action of the average individual is apt to be wiser than the action of Congress —not because he is wiser than the average Congressman, but because he is dealing with a problem more or less level with his powers, whereas Congress undertakes to deal with one wholly beyond its powers.

A strong point made by Mr. Atkinson is his demonstration that even "infant industries" do not need to be nursed by a tariff when they are properly located and have large markets open to them. The instance he cites is that of our own iron and other manufacturing interests in the Southern States. On the principles we constantly hear maintained by protectionists, the manufacturing industries of Pennsylvania and Massachusetts should have crushed out any attempt at competition in the South, the latter being unable to "protect" itself by a tariff; but nothing of the kind has happened, and Southern industries are yearly increasing in volume and importance. This is an argument to which there is no answer. If the industries of the South could maintain and develop themselves in the face of the competition of heavily subsidized industries, commanding vast capital and fully organized, in the North, will any one pretend that our national industries, so far as they were in any way suited to the country, could not have maintained and developed themselves in the face of foreign competition?

We can not but believe that the common sense of the country will see before long that this, the youngest of nations, instead of leading the van in the application of sound and progressive principles of economic policy, has been hugging to its bosom the narrowest

and most unenlightened principles of an antiquated state-craft. While the spread of knowledge and the improvement in means of communication are drawing men together, and more or less effacing the lines of separation between nation and nation, this country, which, having received, in point of territory and material resources, the fairest and richest heritage of all, might have been expected to show the brightest example of good feeling and hospitality to other peoples and governments, has apparently considered it its mission to antagonize as far as possible the unifying influence of the modern spirit, to counteract the work of science in drawing the nations together, and to promote to the extent of its power a *régime* of international exclusiveness and jealousy. Shall we not some day wake up to a sudden shame of our conduct as a people in this matter? Shall we not some day be led to feel that we owe the world a better example? What is the use of endowing colleges and teaching the rising generation how to subdue the forces of nature, if, after the forces of nature have been subdued, and the life-giving and health-giving currents of international intercourse are prepared to flow in full tide of beneficent activity, we empower a lot of politicians at Washington to place artificial obstacles and resistances in the way of our commerce? The thing is really too absurd — philosophy and religion alike proclaiming the solidarity of human interests, science showing how natural obstacles to intercourse may be reduced to a minimum, while politics—flouting all the teachings of religion and philosophy, handicaps the achievements of science and insists on the perpetuation of a semi-barbarous *régime* of international hostility. Does any one say the word "hostility" is too strong? It is not too strong. What more hostile thing can we do to any one than to refuse intercourse with him? What deadlier or crueller form of hostility is there than the "boycott"? Of course, in boycotting others, we boycott ourselves; for, big as we are, we are not the whole world. What Mr. Atkinson is striving to show is the injurious effect of the boycott upon ourselves. We heartily wish him success in his patriotic labors; but we could wish also that a more generous sentiment might come and help to lift us out of our present false and retrograde position.

Our biographical sketch this month is devoted to Prof. T. C. Mendenhall, Superintendent of the Coast Survey and retiring President of the American Association for the Advancement of Science. As the author of the sketch rightly observes, we have in this gentleman a typical specimen of that class of Americans who, by the determined cultivation and development of their natural gifts, have arrived at the highest distinction. Many perhaps will consider the surroundings of Prof. Mendenhall's boyhood as unfavorable to his becoming eminent; but there is an element in his early school training, commonplace as that may appear, which to our mind was decidedly favorable, because it contributed directly to the formation of those habits of observation and independent thinking which are conspicuous in the characters of able men. Deriving from his father an inquiring turn of mind, the boy was fortunate enough to fall into the hands of a teacher who was an interested observer of physical phenomena, and who was in the habit of occasionally varying the school-work by such simple experiments as were within the means at her command. Insignificant as this episode may appear to many, it was well calculated to arouse the interest and fix the attention. The native curiosity of the childish mind was stimulated, and observation, experiment, and reasoning on his own account were the natural result.

Under the system of public-school administration that now prevails, especially in our large cities, this Quaker lady would not have been allowed to break the tedious routine of book-study with any such diversions. Any attempt on her part to observe the individual aptitudes of her pupils, to foster them, and qualify the boys to put their faculties to the best use of which they were capable would have been frowned down as inconsistent with the true purposes of the school. On the other hand, she would have been compelled, under penalty of dismissal, to put them all through an identical Procrustean drill, which tends to dull the faculties, suppress the aptitudes, and destroy that individuality of character in which alone resides the possibility for the highest usefulness of the man.

LITERARY NOTICES.

THE ART OF AUTHORSHIP. Compiled and edited by GEORGE BAINTON. New York: D. Appleton & Co. Pp. 355. Price, $1.25.

THIS book is described in its sub-title as Literary Reminiscences, Methods of Work, and Advice to Young Beginners, personally contributed by Leading Authors of the Day; and, rightly used, it may be of great assistance to all persons who desire to write well. The compiler, seeking material for illustrating a lecture on the Art of Composition and Effective Public Speech, bethought himself to secure, if possible, personal experiences and counsels from a few of the leading writers and speakers of the day. The volume is the outcome of that effort. Replies are published from one hundred and seventy-nine English and American authors—poets, novelists, essayists, historians, and scientific writers—each giving an account of his literary history, methods in composition, or his impressions of what constitutes good writing, and how the object is attained. Many of the contributors compress their views into a sentence or even a maxim; and there is a singular unanimity in the conclusion which they all reach. The whole lesson of this book of the experiences of more than a hundred and seventy-five successful authors may be expressed by saying that the art of good writing consists in having something to say and saying it in the clearest manner possible. A few of the expressions of representative authors in different fields may be quoted. The compiler has attempted to classify the observations under such headings as Good Writing: a Gift or an Art? Methods, Conscious and Unconscious; On Literary Style; The Strength of Simplicity; A Protest against Obscurity; and Truthfulness to One's Self; but the divisions so blend into one another, and all cluster so immediately around the single principle already stated, that we have found it impossible to keep the lines distinct. Prof. Huxley would advise the young writer, rather than ape the great writers, to make his style for himself, as they did. They were great "because, by dint of learning and thinking, they had acquired clear and vivid conceptions about one or other of the many aspects of men and things; . . . because they took infinite pains to embody those conceptions in language exactly adapted to convey them to other minds; . . . and because they possessed that purely artistic sense of rhythm and proportion which enabled them to add grace to force, and, while loyal to truth, make exactness subservient to beauty." To Prof. Tyndall, to think clearly is the first requisite; next, to express clearly in writing what he thinks. But this is not enough, and, with a good ear, sound judgment, and a thorough knowledge of English grammar, one must have a peculiar sensitiveness to the charm of a good style. The only tendencies that enable Mr. Francis Galton to write intelligibly "are a great desire to be clear in thought and distinct in expression, and an inclination to take much pains." He has, further, a clear appreciation of good and clear writing by others, and a love of getting at the exact meaning of words. Sir John Lubbock thinks that "there is no better way to improve one's style than by the study of the greatest masters of English." Grant Allen attaches much importance to the average classical education, and looks out deliberately for the most graphic and interesting way of putting things. John Burroughs believes that "earnestness is the great secret of forcible composition." Mr. Lowell has formulated the rule that every sentence must be clear in

itself and never too long to be carried, without risk of losing its balance, on a single breath of the speaker. Mr. Stedman would advise the literary aspirant that the first thing is to have "something he must say or express, and then he will say it in his natural and special way; and his way forms his style, and his style is thus the man." Mr. R. D. Blackmore, author of Lorna Doone, first makes sure what he means, then arranges the words in straight order without waste, and then looks at them, with a stranger's mind, to learn whether he would take them as himself had done. Mr. Edward Dowden regards as the most important thing, in writing narrative, "to discover and then conceal a rational order in the sequence of topics." In many cases the "logic" would be one of the emotions rather than of the intellect. Mr. F. Marion Crawford advises boys to cultivate style by taking pains about their letters. Mr. Thomas Hardy's impression is that if one "has anything to say which is of value, and words to say it with, the style will come of itself."

SEMITIC PHILOSOPHY: Showing the Ultimate Social and Scientific Outcome of Original Christianity in its Conflict with Surviving Ancient Heathenism. By PHILIP C. FRIESE. Chicago: S. C. Griggs & Co. Pp. 246.

THE speculative theories of the Semites are not discussed in this work, as might be supposed from its title. It is named Semitic to distinguish it from "the philosophies of Greece and Rome and the Orient," and because the author of its great revival was a Semite. We learn that it is "the Christian doctrine of the kingdom of God," and that this formula implies a philosophy "all of which may be grasped into the one first principle as the uniformity of the uniformities of God's action." Christ did not intrust this precious system to writing because language is defective, but he "referred its keeping" to a better vehicle of thought, "the sensuous ideas." These are explained as possessing magnitude, color, motion, and relative place; superior to the differentials of mathematics, in that they are qualitative as well as quantitative, and, to cap the climax, they are "constructed, like the rest of the body, by man's spirit"! In spite of the inefficiency of language, Mr. Friese gives us "An Ideal Written Social Constitution" and describes in another chapter a grand social reformation. Whether we agree or not with his remedies and conclusions, he fully persuades us that words are poor instruments, and a mark for the unwary.

MONOGRAPHS OF THE UNITED STATES GEOLOGICAL SURVEY. Volume XV. THE FLORA OF YOUNGER MESOZOIC FLORAS. By WILLIAM MORRIS FONTAINE. Part I, Text; Part II, Plates. Washington. Pp. 377, Plates 180.

IN his introduction the author states that the formation whose flora he describes was for a long time included in the so-called Trias of the Atlantic slope. Prof. W. B. Rogers, however, early recognized the difference between this group of strata and most of the Mesozoic of Virginia. Nearly all the plants described in this work were collected by the author in Virginia; the few others were obtained from Maryland. The extent of the ground that Prof. Fontaine has examined makes him confident that the fossils herein described give a fair notion of the flora of the "Potomac" period. He gives the locations of the places in which plants have been found, and describes the mode of occurrence of the specimens. He describes also the location and geology of the Potomac beds. The botanical descriptions of the species to the number of three hundred and sixty-five occupy the greater portion of the volume of text. A series of tables, comparing the Potomac plants with previously described fossil floras, are appended by permission of Prof. Lester F. Ward, by whom they were prepared, for his own use.

BULLETINS OF THE UNITED STATES GEOLOGICAL SURVEY. Nos. 54, 55, 56, and 57. Washington.

THE first of these four bulletins is a volume of over three hundred pages by *Carl Barus*, entitled *On the Thermo-electric Measurement of High Temperatures*. In the introduction a general account of methods of pyrometry is given. The first chapter deals with the degree of constant high temperature attained in metallic vapor baths of large dimensions. The calibration of electrical pyrometers, by the aid of fixed thermal data and by direct comparison with the air thermometer, is fully described. A disp-

ter is devoted to certain pyro-electric properties of the alloys of platinum, and the pyrometric use of the principle of viscosity is set forth at length. The monograph is copiously illustrated with cuts of apparatus, charts, and diagrams.

No. 55 is a *Report of Work done in the Division of Chemistry and Physics*, by *Frank W. Clarke*, Chief Chemist. It embraces papers recording examinations of a number of minerals, and miscellaneous analyses of various minerals and waters.

No. 56 is a paper on *Fossil Wood and Lignite of the Potomac Formation*, by *Frank H. Knowlton*, giving a history of the study of the internal structure of lignites, and systematic descriptions of silicified species.

No. 57 is a *A Geological Reconnaissance in Southwestern Kansas*, by *Robert Hay*. It gives an outline of the geological features of the region, incidentally touching upon points that have an economic bearing. The paper is accompanied by a geologic map of southwestern Kansas, and by diagrams of sections and buttes.

PESTALOZZI, HIS LIFE AND WORK. By ROGER DE GUIMPS. Authorized Translation by J. Russell, with an Introduction by the Rev. R. H. Quick. New York: D. Appleton & Co. Pp. 458. Price, $1.50.

IT is very proper that the Life of Pestalozzi should be the first biographical work to be incorporated in the International Education Series. No one, perhaps, of the devoted men who have labored for the advancement of education has singly contributed more to its improvement or left a broader mark upon its after-course than he. It is to him, says the author of this work, that we owe the reform of elementary education—a reform, however, which, notwithstanding the progress already made, is far from complete; and his history must, above all, be a history of the great idea which, in its successive stages, he sought to put into practice. This idea was the education of all the people, and that by drawing out their faculties. The conception of a learned education had already been worked out before his time, but this could only be for the few. Pestalozzi's life was an effort to realize his idea of the extension of the privileges of education. It was, Dr. Harris remarks, "a succession of experiments, each ending in a failure of some sort. These failures are followed by a period of depressive reflection, in the course of which Pestalozzi seems to become conscious of the personal weakness or unwisdom that had caused his plans to go wrong. He puts the fruits of his experience into a treatise, and is inspired to begin again a new experiment." These experiments and reflections are set forth in detail in Baron de Guimps's vivid memoir, which is prepared very largely from Pestalozzi's letters. His first experiments were made with his son, upon whom he intended to apply Rousseau's ideas. But he was compelled at every step to stop and fall back upon his own observations and the memory of the teachings of his mother, who had devoted herself with complete abnegation to the education of her children. "Struck by the child's natural need of continual activity, and by the abundance and versatility of its physical, moral, and intellectual faculties, it occurred to him that by guiding all these powers aright, and by varying work in such a way as to prevent fatigue, it would be possible to teach children not only to earn their bread, but to cultivate their intellectual and moral nature at the same time." So he projected his agricultural and manual labor institution at Neuhof, the close of which, after five years, was followed by the publication of a series of works in which his ideas were presented free from all foreign alloy. The results of his succeeding experiment at Stanz, as summed up by Morf, show forth the essential principles upon which the general reform of elementary education in the present century has been conducted. His career at Burgdorf is chiefly remarkable for the illustrations it afforded, in his method and in the books he made there, of the doctrine of sense-impressions as the foundation of instruction. The lamentable failure at Iverdun left Pestalozzi at eighty years of age with his hopes disappointed and his illusions dispelled. But it did not break his courage or stop his activity. He immediately set himself to work, and wrote the Song of the Swan, one of his most remarkable books; the Experiences of my Life, in which he blamed himself for all his misfortunes; a fifth part of his Leonard and Gertrude, and a supplement to his Book for Mothers. The story of his life, the telling of which is invested with a great deal of

interest, is followed by a chapter of Personal Recollections by the author, who was one of Pestalozzi's pupils at Iverdun; and by accounts of his Religion, his Philosophy, and his Elementary Method, and of Niederer's Collaboration.

REPORT OF THE ROYAL COMMISSION ON THE MINERAL RESOURCES OF ONTARIO AND MEASURES FOR THEIR DEVELOPMENT. Toronto: Warnick & Sons. Pp. 566.

THE plan of the commission in outlining its work included inquiry into the geology of the province, with special reference to its economic minerals; description and maps of the working mines and important undeveloped mineral resources; trade in mineral products; information and suggestions on the subject of mining laws and regulations; and inquiry into the best means of promoting metallurgical industry. Its methods included examination of witnesses and personal visitation of important districts and places. A section of the report on the geology of the province includes a systematic account of each of its rock formations, with such a sketch of the general geological features of North America beyond Ontario as was necessary to make the description more complete and intelligible. In it the entire results of the geological surveys, otherwise scattered through many volumes of reports, are summarized and made accessible. The evidence that Ontario possesses great mineral wealth is abundant and is constantly accumulating. There are iron ores, gold, galena, arsenic, mica, fibrous serpentine, apatite, granite, and plumbago in the central and eastern counties; copper and nickel mines in the Sudbury district; gold-bearing quartz, copper, and nickel in the township of Denison; gold and silver bearing veins, iron, copper, galena, and "immense quarries of marble" along the north shore of Lake Huron; gold, silver, copper, iron, galena, plumbago, zinc, granite, marble, serpentine, and sandstone north of Lake Superior; a rich silver district west of Port Arthur, and beyond this district gold-bearing quartz, magnetic iron ore, and what is believed to be a continuation of the Vermilion iron range of Minnesota; and gold-bearing veins in the islands of the Lake of the Woods. A practical business basis has been reached in the development of a number of the minerals, as, for example, in the production of salt, petroleum, phosphate, mica, cement, gypsum, and building stones, and in the manufacture of brick, terra-cotta, tile, and sewer-pipe. Silver, copper, and nickel mines are worked with much skill and energy; iron-mining has been intermittent, but has good prospects; and it is confidently hoped that gold-mining will become one of the established industries of the country.

GLIMPSES OF FIFTY YEARS: THE AUTOBIOGRAPHY OF AN AMERICAN WOMAN. By FRANCES E. WILLARD. Introduction by Hannah Whitall Smith. Chicago: Woman's Temperance Publication Association. Pp. 700.

THE journals in this voluminous record are psychologically a contrast to the diary of Marie Bashkirtseff. "I have the desire of living upon this earth by any means in my power," wrote the young Russian artist, consumed by feverish thirst for fame. Twenty years earlier, a girl upon the Wisconsin prairie, struggling with aspiration, cried out, "What is it—what is it that I am *to be*, O God?" In this effort *to be*—not merely to be celebrated at any cost—there are no morbid yearnings for sensation, but a healthful striving for extended usefulness.

Miss Willard views her life in six phases: The welcome child, the happy student, the roving teacher, the tireless traveler, the temperance organizer, and the woman in politics. Three chapters descriptive of her girlhood, passed on a farm in Rock County, Wisconsin, give attractive sketches of pioneer life happily conditioned. There were no schools in this district, nevertheless the family was well educated. The mother had been a school-teacher, and was well read; the father was a student of Nature, and trained the children to observe the ways of birds and butterflies, the habits of gophers, squirrels, and ants; to know the various herbs, and what their uses were; to notice different grasses, and learn their names; to tell the names of curious wild flowers.

Very naturally the daughter became in later years "Preceptress in Natural Sciences." Her girlish habits show an early distaste for ordinary feminine occupations. Her life, as a student at Milwaukee College and the Northwestern Female College, is in-

scribed with enthusiasm, and her subsequent experiences as teacher in eleven schools, ending as Dean of the Woman's College at Evanston, are vividly given with interesting details. Miss Willard was by nature, however, neither a student nor a teacher. Routine was distasteful to her, and patient interrogation of Nature or life was foreign to her restless disposition. The opportunity for extensive travel with a friend accorded with her desires, and two years were spent abroad journeying over Europe, Syria, and Egypt. Shortly after her return she was invited to lecture upon her foreign gleanings, and soon drifted into public speaking. The latter and larger half of the book is devoted to the organization of the W. C. T. U., temperance talks, political speeches, reports of conventions, eulogies of men and women, and dissertations on problems social, industrial, and sanitary. It is to be regretted that these questions are too exacting and tumultuous to be satisfactorily laid to rest. It may be that the failure to give approximate solutions is connected with the mathematical inability which troubled Miss Willard as a teacher, and which is very conspicuous in the arrangement of her book. Her logical horizon is indicated by the following estimate of "one of the kings of the nineteenth century": "Meeting the skepticism of science with its own 'scientific method,' he *proves* that, if a man die, he shall live again!" But it must be remembered that we are told, in the introduction to this encyclopedic volume, that it is "a home book, written for her great family circle, to be read around the evening lamp by critics who love the writer, and who want to learn from her experience how to live better and stronger lives." This indulgent jury of half a million readers will doubtless render a verdict of unanimous praise, but an even larger audience may be unexpectedly entertained by this life-story, and find it worthily called "an object-lesson in American living."

THE STUDENT'S ATLAS. By RICHARD A. PROCTOR. London and New York: Longmans, Green & Co. Price, $1.50.

IN this little work, which was issued just before Prof. Proctor's death last year, the originality of its author is strongly evident. In most atlases, the different divisions of the earth are represented on different scales and often on different projections, so that the ideas they convey as to the shape and relative positions of the various land areas are far from correct. The oceans generally are not mapped at all, so no idea is given of the tracks of vessels across them, nor of the directions from each other of different parts of their shores. Prof. Proctor has avoided these defects in his atlas by depicting the whole surface of the globe on twelve maps, each representing the part of the surface of a sphere corresponding to one side of an inclosed dodecahedron. The maps are all on one scale and a uniform projection, and each occupies a double octavo page. There are also two index maps, which show the connection between the maps of the series. A brief description of each map is given in the introduction, and on the pages between the maps, usually left blank, Prof. Proctor gives the number and chief contents of the map on the other side of the leaf.

THE ECONOMIC BASIS OF PROTECTION. By SIMON N. PATTEN, Ph. D. Philadelphia: J. B. Lippincott Company. Pp. 144. Price, $1.

WE have wondered why some adherent of protection did not get out a book of this sort; for, in view of the pronounced tendency of free-traders to base their creed on fundamental principles, the neglect of protectionists to do the same looks like a confession that protection has no principles on which to stand. But now Prof. Patten has undertaken to give briefly the reasons for the faith that is in him. He asserts that free-traders take as their ideal a society in a "static" condition, while for a society in a "dynamic" or progressive state, which is the actual condition of America, protection is the only admissible policy. He maintains that a locality should not be encouraged to devote itself to the exclusive production of the commodity which it can yield best, because the surplus must pay the cost of long transportation to a market. A variety of things should be produced, and only such quantities of each as can be consumed in the vicinity. Although not so large a gross result could be obtained in this way as by devoting the productive power of the community to a specialty, the author evidently

believes that the net return would be greater. Many of our raw materials come from countries where industry is irregular and ineffective, and Prof. Patten argues that we should make ourselves independent of such sources of supply. He says that skill and capital employed in an orderly community will generally outweigh climatic and other natural advantages in an uncivilized country. As an instance he mentions the production of sugar in Germany from beets in competition with the cane-sugar of Cuba. Wool, he says, will be high in price while it remains the exclusive product of regions distant from the markets, and can only become cheaper when farmers in highly civilized communities take to raising sheep in connection with their agriculture. Prof. Patten maintains that trade between merchants of different countries which is profitable to the individuals is not necessarily profitable to the countries. Supposing a pound of coffee in Brazil would buy three pounds of sugar, while if taken to Cuba it would buy four pounds. In this case a trade profitable to dealers would spring up, and Prof. Patten asks whether such a commerce is so beneficial that the loss of it would work permanent injury to both nations. This, he says, is a matter of dispute. There are many other things in the book that friends of free trade will regard as matters of dispute, which are not so designated by the author. The volume is adapted to provoke discussion, and perhaps the more so because its small size prevents the insertion of facts and figures in support of the author's positions.

EIGHTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY, 1886–'87. By J. W. POWELL, Director. Washington. Parts I and II. Pp. 1095.

IN this report the director gives a full description of the business organization of the Survey, comprising the division of disbursements and accounts, the division of illustrations, the division of library and documents, and the editorial and miscellaneous division. During the year covered by the report, an aggregate area of 55,684 square miles had been surveyed during the field season and mapped during the office season. Topographic work was pushed forward vigorously in Massachusetts, at the joint expense of the State and Federal Governments, and the surveys of that State and of New Jersey are now practically completed. The survey of the District of Columbia and contiguous parts of Virginia and Maryland was finished, work was prosecuted in the southern Appalachian region with a large force, and extensive tracts were surveyed in the Western States and Territories. During the year geologic investigations were carried on by Prof. Pumpelly on the Archæan rocks of New England, by Prof. Irving among the iron-bearing and copper-bearing rocks of Lake Superior, by Prof. Shaler on the tide marshes of the Atlantic coast, and by Mr. Gilbert on the structure of the Appalachian Mountains. Mr. Woodward made a careful resurvey of Niagara Falls, and investigations in glacial geology were carried on under Prof. Chamberlin. The combined investigations of the general geologic structure, and of the coal, oil, gas, etc., of Montana were somewhat crippled by the long illness and finally by the consequent resignation of the veteran geologist, Dr. Ferdinand V. Hayden, but during the latter part of the year the work was carried on by Dr. Peale. Other fields in which work was prosecuted are the Yellowstone National Park by Mr. Hague, the structural and mining geology of Colorado by Mr. Emmons, the volcanic deposits of California and Oregon by Captain Dutton, the iron-ore and marl beds of northern Mississippi and Louisiana by Mr. Johnson, and the Quaternary deposits of the coastal plain between North Carolina and New York under Mr. McGee. The area affected by the Charleston earthquake was also examined, and Mr. Becker completed his report on the quicksilver mines of the United States. Work in paleontology was carried on by Prof. Marsh, Mr. Walcott, Dr. Dall, Prof. Ward, and Mr. Scudder. One of the most important events of the year in systematic geology was the discovery by Dr. White and Mr. Hill of a great series of Cretaceous strata in Texas underlying the rocks hitherto regarded as the base of the American Cretaceous, and corresponding in many respects with the Lower Cretaceous deposits of Europe. Chemical work was carried on by Prof. Clarke, Mr. Chatard, and Messrs. Gooch and Whitfield. Mr. Day continued the collection of mining statistics. Several miscellaneous researches were also in progress. The report of the director is supple-

mented by administrative reports from the heads of divisions, which give further details concerning the work of the year. The following papers also accompany the director's report: Quaternary History of Mono Valley, California, by Israel C. Russell; Geology of the Lassen Peak District, by J. S. Diller; The Fossil Butterflies of Florissant, by Samuel H. Scudder; The Trenton Limestone as a Source of Petroleum and Inflammable Gas in Ohio and Indiana, by Edward Orton; The Geographical Distribution of Fossil Plants, by Lester F. Ward; Summary of the Geology of the Quicksilver Deposits of the Pacific Slope, by George F. Becker; and The Geology of the Island of Mount Desert, Maine, by Nathaniel S. Shaler.

JOHNS HOPKINS UNIVERSITY STUDIES IN HISTORICAL AND POLITICAL SCIENCE. Eighth Series. Edited by HERBERT B. ADAMS. Baltimore. Published monthly.

THE first subject treated this year in these studies was *The Beginnings of American Nationality*, by *Albion W. Small*, of which Chapters I, II, and most of III are given, forming a double number. (Price, one dollar.) The scope of this inquiry comprises the constitutional relations between the Continental Congress and the colonies and States from 1774 to 1789. Chapter II tells the composition and organization, and the acts of the Congress of 1774, and the corresponding acts of the colonies; while Chapter III gives a similar history of the Congress of 1775. A ten-page paper on *The Needs of Self-supporting Women*, by Miss *Clare de Graffenreid*, is included in the same pamphlet.

Part III of the current series contains an essay on *Local Government in Wisconsin*, by *David E. Spencer*, together with a sketch of *The Enoch Pratt Free Library* in Baltimore, by *Lewis H. Steiner*. (Price, twenty-five cents.)

Spanish Colonization in the Southwest is treated in Part IV, by *Frank W. Blackmar*. (Price, fifty cents.) This is an account of the efforts of Spain, by military, religious, and civil means, to colonize and secure control of California and the territory north of Mexico. It embraces a sketch of the celebrated mission system employed to Christianize the Indians of Upper California.

A double number is devoted to *The Study of History in Germany and France*, by *Paul Frédéricq*, being translations by Miss *Henrietta Leonard* of two papers by Prof. Frédéricq, of Ghent. (Price, one dollar.) In these papers the methods of the professors, the cources that they prescribe, and even their personal appearance and the habits of the students, are given in detail, and in a familiar and often amusing style. At one of the lectures in the University of Berlin, Prof. Frédéricq saw a listener using an ear-trumpet, and he tells us all about the queer contrivance in a foot-note. Among the masters of historical teaching whom he heard lecture in Germany were Treitschke, Droysen, Curtius, Pauli, Waitz, and Von Sybel. He also called upon Von Ranke, who no longer lectured. In Paris he heard MM. Alfred Maury, Paul Meyer, Victor Duruy, Monod, and Lavisse. In the same pamphlet with these papers is included a sketch of *Early Presbyterianism in Maryland*, by Rev. *J. William McIlvain*.

NATIONAL HEALTH. Abridged from The Health of Nations. A Review of the Works of Sir Edwin Chadwick, K. C. B. By BENJAMIN WARD RICHARDSON, M. D., F. R. S. London and New York: Longmans, Green & Co. 1890. Pp. 320. Price, $1.50.

THE demand for an inexpensive form of Sir Edwin Chadwick's writings led to the preparation of this volume. Selections have been made from the subject-matter of Health of Nations, omitting explanatory paragraphs, chapters relating to police regulation, poor-law administration, and historical accounts of sanitary effort. The essays have been rearranged and well classified in four parts: health in the dwelling-house; health in the school; health in the community; and health in the future. Under the first head the construction and economy of sanitary dwellings is considered, and the best mode of drainage, ventilation, warming, and securing freedom from dampness. The value of soft water is urged, and roof-gardens are recommended for crowded districts. The benefit of healthful homes is shown in the establishment of improved dwellings for working people in London, where the death-rate has been reduced in some localities from forty-two to eighteen per thousand.

The *half-time system* in education, which

Mr. Chadwick originated, is explained in Part II. This combination of mental and manual training we are beginning to recognize as a better educational method than mere cultivation of intellectual faculty. Mr. Chadwick states as a result of trial, "where there have been good approximations to the proper physiological as well as psychological conditions, as in the half-time industrial district schools, epidemic diseases have been banished and the rate of mortality reduced to one third of that which prevails among the general community." Among the more important subjects discussed in Part III are: practical remedies for intemperance, health *versus* war, and the connection of bankruptcy with ill health. In the closing chapters the financial outcome of better sanitation is figured; the lowering of the death-rate results in curtailment of funeral expenses, saving of labor and reduction of outlay in police and penal administration.

The dominant idea of the book is that prevention of disease, poverty, and crime is more economical than cure. It is singularly free from dogmatic assertion, and every practical suggestion is founded upon close observation or supported by careful study of statistics. Dr. Richardson has performed no slight labor in rendering this work accessible; it occupies less than half the space of Health of Nations, presents the biographical sketch in a shorter form, and contains an autotype portrait of the eminent sanitarian.

ADVANCED PHYSIOGRAPHY. By JOHN THORNTON, M. A. London and New York: Longmans, Green & Co. Pp. 342. Price, $1.40.

THE scope of this volume has been made to conform to the syllabus for the advanced stage of physiography of the Science and Art Department of the Museum at South Kensington, London. The matter that it includes falls largely in the field to which the name New Astronomy has been given. In the words of the preface: "It is concerned more with the physical and chemical constitution of the heavenly bodies than with their exact positions and movements, as discussed in the older department of astronomy. This older branch, however, has not been entirely neglected." Nearly all the contents of the book could be included under the heading astronomy, though there are chapters dealing with atmospheric and oceanic movements, terrestrial magnetism, measurement of the surface, size, and shape of the earth, secular cooling of the earth, and secular changes of climate. An appendix contains several tables, a number of paragraphs relating to the formation and the analysis of rocks, and a list of examination questions. Physiography in the title of this book is not equivalent to physical geography as it is often intended to be elsewhere. All the chapters are fully illustrated, especially those relating to spectrum analysis and to the constitution of the sun. A colored plate of spectra is also inserted.

MONOGRAPHS OF THE UNITED STATES GEOLOGICAL SURVEY. Volume XVI. THE PALEOZOIC FISHES OF NORTH AMERICA. By JOHN STRONG NEWBERRY. Washington. Pp. 340. Plates, 53.

THE matter of this monograph is arranged with the design of representing the progress of fish-life in North America during the golden age of the fish tribe, as illustrated by the large amount of material that has come into the author's hands. He has undertaken to give references to all notices of our older fossil fishes hitherto published, and has added to them descriptions and figures of all the new forms that he has met with. The new material described has an important bearing upon some general questions as to the origin and development of fish-life on the earth which are referred to as they come up in the chronological arrangement of the descriptions. The fishes are described in the order of their geological systems, beginning with the oldest. The review stops at the top of the Coal Measures, as no Permian fishes from this country have ever come under the author's observation.

The subject taken by the president, *Lester F. Ward*, for his address at the tenth anniversary meeting of the Biological Society, of Washington, was *The Course of Biologic Evolution*. In opening, Mr. Ward spoke of the common error in regard to evolution, which puts every form of creature that lives or ever has lived among the direct ancestors of the human species. The course of biologic evolution has been rather like the branching growth of a tree, and Mr. Ward sets forth some of the laws in accordance with which

this development takes place. The first is the extinction of trunk lines of descent, by virtue of which a trunk sends up a branch which is capable of higher progress than the trunk itself, and in time comes to be regarded as the trunk. This in turn sends up a branch by which it is overtopped and superseded as the trunk of the ever-branching system. Another law is that of persistence of unspecialized types, instances of which are the persistence of low forms of articulates, mollusks, and reptiles with the dominant types of animals, while the higher forms of these orders have been extinguished by competition with these dominant types. Turning to the vegetable kingdom, Mr. Ward points out by what steps development has proceeded in this field from its earliest beginnings in cryptogamic life to its highest and latest expression in the gamopetalous dicotyledon. He then considers the influence in the modification of structure exerted by extra-normal causes—i. e., such as produce characters that are of only indirect use to the organism. The doctrine of natural selection has been severely criticised of late years, and the best way of defending it, Mr. Ward believes, is to take the ground that fortuitous variation goes on at all times, in many directions, and to great lengths, without any perceptible change in the degree of adaptation which the varying forms have to their environment. No beneficial effect need be felt until well-formed varieties have been developed. Among extra-normal influences in the vegetable kingdom are showy and fragrant flowers, and bright-colored and pleasant-flavored fruits. Another important influence of this class comprises the causes which in many cases make one sex differ so widely from the other.

An address was given by Dr. *Byron D. Halsted*, State Botanist of New Jersey, before the New Jersey Board of Agriculture last winter on the subject of *Rusts*, *Smuts*, *Ergots*, and *Rots*, in which he described some of the diseases that seriously affect field-crops, vegetables, and fruit, and named remedies that have proved successful in combating them. The paper comes to us in pamphlet form. It is free from botanical technicalities, and hence can be understood and used by any intelligent farmer. A list of the fungi most injurious to New Jersey farm-crops is appended, together with four plates in which many of them are figured.

Part VII of Volume I of the *Records of the American Society of Naturalists* contains a list of members, with their professional positions and addresses, and a record of the eighth meeting of the society, held in New York, December 27 and 28, 1889. The president, Prof. Goodale, of Harvard, took Science in the Schools as the subject of his address, and suggested as a means of securing genuine science study in the lower schools the preparation of a book on physical geography, the part relating to each tributary science to be made by a master of the science, and the whole to be co-ordinated by a master in pedagogics. An outline of laboratory work in each of the sciences should be included, some one of which should be selected by the teacher for his pupils to become practically acquainted with. Since the last meeting of the society, the addition of science to the requirements for admission to college, and to the general course of study in common schools, has been urged in the name of the society by Prof. William N. Rice and other members before various educational associations. The officers elected for the present year include Prof. H. Newell Martin, president, and Prof. Henry H. Donaldson, of Clark University, secretary.

A detailed examination of *The Marine Climate of the Southern California Coast and its Relations to Phthisis* has been published in a pamphlet by *P. C. Remondino*, M. D., of San Diego. In passing from the islands off the coast to the mountains and down into the desert beyond, the author distinguishes six varieties of climate that are met with. Three of these have more or less of a marine character, while the others are land climates, but none of them can be called moist. Dr. Remondino tells what are the prevailing temperatures, quantities of air-moisture, character of the seasons, weather, etc., in different parts of the region he describes, and bears confident testimony as to the benefits that consumptive patients may expect from the dry and equable air of the coast, or the foot-hills, or the mountains of southern California.

Bulletin No. 22 of the Department of Agriculture consists of *Reports of Observations and Experiments in the Practical Work*

of the Division, by a number of agents. It comprises reports on methods for destroying the red scale of California, by D. W. Coquillett; on insects of the season in Iowa, by Herbert Osborn; on insects affecting grains, by F. M. Webster; on California insects in general, by Albert Koebele; on Nebraska insects, by Lawrence Bruner; and entomological notes from Missouri for the season of 1889, by Mary E. Murtfeldt.

The address of *William L. Dudley*, before the American Association at Toronto last year was on *The Nature of Amalgams*. It is now published as a pamphlet, and is mainly occupied with a history of discoveries relating to the chemistry of amalgams. It contains a bibliography of the subject, occupying eleven pages.

In a paper on *The Cradle of the Semites*, read before the Philadelphia Oriental Club, Dr. *D. G. Brinton* brings together the evidence tending to show that the progenitors of the Israelites were of a blonde type, and came to Asia from northwestern Africa. Prof. Morris Jastrow, Jr., replied to this in a paper directed to showing the insecurity of some of the grounds that Dr. Brinton had taken. The two essays are published in a pamphlet together.

A table of *Poisons and their Antidotes* has been issued by The National Druggist (Druggist Publishing Company, St. Louis). It is printed on one side of a sheet of strong manila paper, and its directions are brief and clear. It would be somewhat more useful to unscientific persons if it stated that sodium and magnesium sulphates are also known respectively as Glauber's and Epsom salts, and if it avoided such words as emetocathartic.

The Report of the Commissioners of the State Reservation at Niagara, for October, 1888, to September, 1889, records the doings of the commission during the year designated, and their recommendations for future work. G. K. Gilbert's History of the Niagara River, noticed in the July number of this magazine, is published in the same pamphlet. The commissioners have issued also a folded sheet containing suggestions to visitors, and a map of the vicinity of the falls.

Students of political science now have an opportunity to compare a translation of *The Federal Constitution of Germany* (University of Pennsylvania, 50 cents) with the Constitution of the United States. The translator is Prof. *Edmund J. James*, who has based his version on the one printed in the Government report on Foreign Relations for 1877. A detailed table of contents is prefixed to the document, and a historical introduction, which is essentially a translation of the corresponding section in Von Rönne's Verfassung des deutschen Reichs.

Among its Circulars of Information for 1890, the Bureau of Education has issued *English-Eskimo and Eskimo-English Vocabularies*, compiled by Ensign *Roger Wells, Jr.*, U. S. N., and Interpreter *John W. Kelly*. These vocabularies contain 11,318 words, and are preceded by twenty pages of Memoranda concerning the Arctic Eskimos in Alaska and Siberia, by John W. Kelly. These memoranda embrace traditions, bits of history and description, customs and superstitions of the Eskimos. Two maps are contained in the pamphlet.

The *School Algebra* of Prof. *G. A. Wentworth*, of Phillips Exeter Academy, is intended to present a thorough and practical treatment of the principles of elementary algebra. It covers sufficient ground for admission to any American college; and it and the author's college algebra are enough to occupy the time given to the subject in our best schools and colleges. The problems are carefully graded, mostly new, and either original or selected from recent examination papers. The early chapters are quite full; and the introductory chapter presents a free discussion of the principles with which the student beginning algebra ought to be acquainted.

Dreamthorpe, a Book of Essays written in the Country (George P. Humphrey, Rochester), is a reprint of some of the prose writings of *Alexander Smith*, who wrote but little, but that little, whether the prose or poetry of it, of such a character as to cause regret that he did not write more, and to give him a place among English classic authors. The title of the work suggests that the essays were written from the domain of fancy; they certainly embody the author's own thoughts, and not what he borrowed from another. In style they are of the very best English. Some of them are purely literary; others

are on such subjects as The Fear of Death and Dying, A Lark's Flight, The Importance of a Man to Himself, Books and Gardens, and Vagabonds.

A series of philosophical papers has been added to the publications of the University of Pennsylvania, under the editorship of Profs. Fullerton and Cattell. The first number of the series is a thick pamphlet by Prof. *George Stuart Fullerton*, entitled *On Sameness and Identity*. In the first part of the essay the author enumerates and defines at length seven kinds of sameness, and then proceeds to discuss the samenesses of the real self. He states that "men use the word identity to mark certain kinds of sameness in which there is little or no consciousness of duality." A second division of the paper is a critical presentation of the ways in which various philosophers have dealt with sameness.

An essay on *Maimonides*, giving an account of his philosophy, has been published by Rabbi *Louis Grossmann*, D. D. (Putnam, 25 cents). In a rough classification Dr. Grossmann would put Maimonides with philosophers of religion, since he devoted special attention to the relation between metaphysics and Jewish theology. While crediting Maimonides with great philosophical insight, Dr. Grossmann is not blind to his limitations, and points out several errors which hampered him in common with his contemporaries.

An autobiography of rare interest is presented in *The Life of George H. Stuart*, written by himself, and edited, at his request, by Prof. *Robert Ellis Thompson*, of the University of Pennsylvania. Mr. Stuart's life was associated with some of the most exciting events of our recent history. As the editor characterizes his career, it "extends through a memorable half-century of our country's history, and touches more or less closely upon all the great religious and philanthropic movements of that time. While he has not taken any part in political life or sought any eminence in that field, he has been brought into contact with many of our public men, from the anti-slavery group of half a century ago, to Lincoln, Grant, and the national leaders of our own time. . . . On the other hand, he has occupied almost a unique position in our ecclesiastical life, as representing that spirit of unity which has been awakened in the American churches during and since the war." Mr. Stuart was born in County Down, Ireland, and came to the United States in 1831, when about fifteen or sixteen years old. In 1836 he heard one of Mr. Gough's temperance addresses, and from that moment became an upholder of every measure for temperance. He was among the first to join the anti-slavery movement. When the question of the union of Presbyterian churches came up, he did his best to advance it. He was instrumental in introducing the Young Men's Christian Association into the United States and in extending its organization. Early in the civil war he saw a place in the matter of care for the condition of the soldiers which the Sanitary Commission, admirable as its organization was, could not wholly fill, and called the Young Men's Christian Association to the institution of the Christian Commission, and became its president. In this position he was brought into relations with the officers of the Government and the army and with the soldiers. When General Grant was chosen President, Mr. Stuart was given the first invitation to be Secretary of the Treasury. The condition of his health prevented his accepting the office, but he was one of President Grant's most trusted counselors, and assisted him in his efforts to have the Indians dealt honestly with. He died in March, 1890. His autobiography, besides delineating himself, is a picture of the times in which he lived, and derives further interest from incidental notices of men eminent in the State, the Church, and philanthropy with whom he had relations.

A number of articles and addresses have been published by Prof. *Charles S. Mack*, M. D., in a small volume under the title *Philosophy in Homœopathy* (Chicago: Gross & Delbridge). The purpose of the book is to furnish students of homœopathy and the general public with arguments on which to rest a belief in homœopathic treatment. One of the chapters is an address to some students in an allopathic medical college, in which a list of questions submitted by the students are answered. An appendix contains an essay on the treatment of criminals, and a discussion of an article by one De

Charms, suggesting an affinity between homœopathy and Swedenborgianism.

A paper by *G. W. Hambleton*, M. D., on *The Suppression of Consumption*, to which we called attention some months ago, when it was published in Science, has been reprinted in a neat pamphlet, with flexible cloth covers (N. D. C. Hodges, 40 cents). It forms the first number of a series to be called Fact and Theory Papers. Dr. Hambleton maintains that consumption is produced by causes that check free respiration and by dusty air, and the first aim of his treatment is to secure the breathing of a full supply of pure air.

Count Tolstoi's Kreutzer Sonata, translated by Benjamin R. Tucker and published by him in Boston, is a story of a man's vehement passion for his own wife, and his consequent jealousy. These feelings become ungovernable upon hearing the performance of the music which gives the story its title, and events following this incident prompt the sufferer to murder. The author's intention, though his method may be mistaken, is to teach a salutary moral lesson.

The *First Annual Report of the Agricultural Experiment Station at Cornell University* covers the eight months from April 30, 1888, to the end of the year. The reports of the director and other officers relate mostly to the business of organization. In transmitting the report to the Governor of New York, Prof. C. K. Adams, President of Cornell University, states that, in organizing the station, the trustees of the university availed themselves in every practicable way of the large resources already forming a part of the College of Agriculture. The completeness of this outfit decided the trustees to use the expenditure for buildings provided for by the Hatch Act in erecting a building for the careful study of noxious insects. Appended to the report are the four Bulletins, which were also issued separately during the year. The chief topics treated in these Bulletins are an Experimental Dairy House, Experiments in feeding Lambs, The Insectary of Cornell University, and Growing Corn for Fodder and Ensilage. All of these papers are illustrated.

Under the title of *How to remember History*, the J. B. Lippincott Company publish a Method of memorizing Dates, with a summary of the most important events of the last four centuries, by *Virginia Comer Shaffer*. Each century is represented by a chart, and the chart is divided into a hundred squares, one for each year. Each square is divided into five subdivisions, answering respectively to events in war and peace; in politics, social and religious life; in literature, science, and art; miscellaneous events; and deaths. Different countries are represented by devices of color. When the date of any event is to be fixed, it is noted by filling in the square standing for the year, the subdivision corresponding with the character of the event, with the color or colors corresponding with the country or countries to which the event relates. To the charts, which are given as specimens of what may be done, texts are appended, embodying a chronological table of the events represented, and reading accounts of the same events of considerable fullness. The plan is capable of indefinite modification and enlargement.

PUBLICATIONS RECEIVED.

Abel, Mrs. Mary Hinman. Practical Sanitary and Economic Cooking. Rochester, N. Y.: American Public Health Association. Pp. 190.

Armas y Cárdenas, José de. Medico-legal Observations on the Case of Don Estéban Verdú (in Spanish). Habana. Pp. 32.

Bean, Tarleton H. New Fishes collected off the Coast of Alaska, etc. Washington: Smithsonian Institution. Pp. 8.

Browning, Oscar. Aspects of Education. New York: Industrial Education Association. Pp. 48. 20 cents.

Childs, George W. Recollections of General Grant. Philadelphia: Collins Printing House. Pp. 104.

Chisholm, George G., and Leete, C. H. Longman's School Geography for North America. New York: Longmans, Green & Co. Pp. 384. $1.25.

Coast, U. S., and Geodetic Survey. Chart Corrections of the Coast.

Cox, Charles H. Protoplasm and Life. New York: N. D. C. Hodges. Pp. 67. 75 cents.

Crooker, Joseph Henry, Madison, Wis. Different New Testament Views of Jesus. Pp. 20.—The Bible and the Public Schools, or Dr. Hasson and the Supreme Court. Pp. 18.

Dall, William H., U. S. National Museum. New Species of Land Shell from Cuba (Vertigo Cubana). Pp. 2.

English, George L. & Co., Philadelphia. Catalogue of Minerals for sale. Pp. 100.

Fall, Prof. Delos, Albion, Mich. Sanitary Science. Pp. 10.

Gilbert, Charles H. Preliminary Report on Fishes collected by the Steamer Albatross on the Pacific Coast of North America. Washington: Smithsonian Institution. Pp. 75.

Goode, G. Brown. Museum-History and Museums of History. Pp. 22.—Origin of the National Scientific and Educational Institutions of the United States. Pp. 112. New York: G. P. Putnam's Sons.—The Literary Labors of Benjamin Franklin. Philadelphia. Pp. 21.

Gurney, E. H. Reference Handbook of English History. Boston: Ginn & Co. Pp. 114. 85 cents.

Hale, Horatio. British Association Report on North American Ethnology. London. Pp. 97, with Plates.

Howard, George E., University of Nebraska. Development of the King's Peace and the English Local Peace-Magistracy. Pp. 65.

Howe, H. M. The Metallurgy of Steel. New York: Scientific Publishing Company. Pp. 380. $10.

Hyde, E. W. The Directional Calculus. Boston: Ginn & Co. Pp. 247. $2.15.

Iowa, State University of. Bulletin from the Laboratories of Natural History. Vols. III and IV. Iowa City. Pp. 180, with Plates.

Jones, Hon. John P., United States Senate. Speech on the Free Coinage of Silver. Pp. 116.

Jordan, David Starr. Catalogue of Fishes collected by the United States Fish Commission Steamer Albatross. Washington: Smithsonian Institution.

Jordan, David Starr, and Evermann, B. W. New Species of Fish from Tippecanoe River, Ind. Pp. 4.

Kiddle, Henry. A Text-Book of Physics. New York: William Wood & Co. Pp. 288. $1.

Lesquereux, Leo. Remarks on some Fossil Remains considered as Peculiar Kinds of Marine Plants. Washington: Smithsonian Institution. Pp. 12, with Plate.

Lewis, T. H. Ancient Fireplaces on the Ohio. Pp. 5.

Loti, Pierre. Rarahu. New York: W. S. Gottsberger & Co. Pp. 296.

Lucas, Frederic A. Catalogue of Skeletons of Birds collected by the Steamer Albatross. Washington: Smithsonian Institution. Pp. 4.

McGill University, Montreal. Annual Calendar of the Faculty of Medicine. Pp. 108.

Mackay, A. H., Halifax, N. S. Fresh-water Sponges of Canada and Newfoundland. Pp. 12, with Plates.

Mohr, Charles, Mobile, Ala. The Medicinal Plants of Alabama. Pp. 17.

Moll, Albert. Hypnotism. New York: Scribner & Welford. Pp. 410. $1.25.

Montgomery, D. H. The Leading Facts of American History. Boston: Ginn & Co. Pp. 359 + lii. $1.10.

Myerovitch. The Origin of Polar Motion. Chicago: Rosenberg Brothers, Printers. Pp. 32.

Nebraska, University of. University Studies. Vol. I, No. 3, July, 1890. Lincoln. Pp. 104.

New Jersey. Annual Report of the State Geologist for 1889. Pp. 112.—Final Report, Vol. II. Mineralogy, Botany, Zoölogy. Pp. 642.

New York Agricultural Experiment Station's Bulletins, Nos. 19 and 20 (New Series). Pp. 40.

North, S. N. Dexter. Bulletin of the National Association of Wool Manufacturers. Quarterly. Pp. 20. 50 cents.

Payne, F. F., Toronto, Ontario. The Eskimo of Cape Prince of Wales, Hudson's Strait. Pp. 8.

Pickard, J. L. School Supervision. New York: D. Appleton & Co. Pp. 175. $1.

Pyat, Felix. The Rag-Picker of Paris. Boston: Benjamin R. Tucker. Pp. 317.

Ridgway, Robert. The Genus Xiphocolaptes of Lesson. P. 1.

Sociedad de Fomento Fabril, Santiago, Chili. Monthly publication. Pp. 48. 40 cents.

Sutton, J. Bland. Evolution and Disease. New York: Scribner & Welford. Pp. 285. $1.25.

Tittmann, O. H. Table for the Reduction of Hydrometer Observations of Salt-Water Densities. Washington: Coast Survey. Pp. 8.

Townsend, George Alfred. Mrs Reynolds and Hamilton. New York: F. Bonaventure. Pp. 276. 50 cents.

Wheeler, Captain George M. Report upon United States Geographical Surveys west of the One Hundredth Meridian. Washington: Government Printing-Office. Pp. 771, with Maps.

White, Charles A. Mesozoic Fossils from Islands of the Strait of Magellan.

POPULAR MISCELLANY.

The Water-Supply of Memphis.—The city of Memphis, Tenn., now possesses a complete supply of pure water, which forces itself through artesian wells from a depth of about four hundred feet below the surface. The artesian source was discovered in 1887 by Mr. R. C. Graves, of the Ice Company, who, seeking water suitable for the manufacture of ice, made borings to the depth of three hundred and fifty-four feet. There he struck water, which at once rose to the surface and spouted up in a gushing fountain. This source has since been utilized in numerous private wells of hotels and manufacturing establishments and in the public supply of the city. It lies in a stratum of "water-bearing sand," nearly eight hundred feet thick, which is reached after boring through the one hundred and forty-five feet of hard, impervious clay that forms the "bed-rock" of the region, and furnishes a permanent bottom to the Mississippi River. Above this is a stratum of gravel twenty feet thick, topped by the bluff formation of loess that constitutes the surface of the region and gives character to it. These formations extend a considerable distance to the eastward, and there outcrop one after the other—the water-bearing sand, which is sandwiched between the clay already mentioned and another clay below it, being represented by a tract twenty miles across and of indefinite length, which may be seen in Fayette and other counties along its line down into Mississippi. This region, on which is gathered the water that percolates to the wells of Memphis, is, in its general surface, about three hundred feet above high water of the Mississippi. In May, 1889, there were fifty-seven bored wells in Memphis, five of which only reached the water-bearing sand, while the others went down to depths of from three hundred and fifty to four hundred feet and more. They are included within an area three miles long and one mile wide. The average depth of the thirty-two wells through which the water-supply is

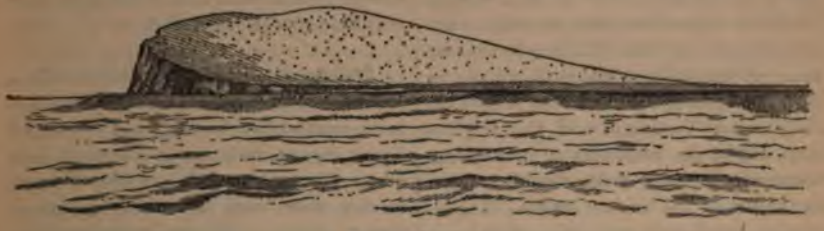
furnished is about four hundred feet. They are all connected by a tunnel, five feet in diameter inside, and walled with brick, which has been constructed in the impervious clay seventy-six feet below the upper limit of artesian flow. From the "wet chamber" of this tunnel, in which the water is collected, it is pumped for distribution over the city. The character of the water is shown by the most careful tests to be of the best.

Science in Iowa.—The paper of most general interest in the Proceedings of the Iowa Academy of Sciences for 1887, 1888, and 1889, is the annual address for 1888 of President Herbert Osborn. It reviews what has been accomplished in Iowa in the various fields of science, and gives a forecast of the directions in which work in the future may be conducted with most immediate advantage. The first Iowa Academy of Sciences, which existed from 1875 to 1884, was the means of encouraging investigation in many parts of the State, and secured the publication of a number of valuable papers. The present Academy, of which R. Ellsworth Call is secretary and treasurer, was organized in 1887. Besides this body, the Iowa Assembly of the Agassiz Association, the State Agricultural and Horticultural Societies, Agricultural College and Weather Service are mediums for scientific publication on subjects appertaining to their respective spheres. Anthropological work has been furthered by the Davenport Academy of Sciences. Much has been done by the geological surveys and by individual naturalists from 1819 on. Continued geological studies and the development of the weather service are indicated as the leading lines on which future scientific work may be prosecuted. The proceedings of the three years covered by the volume contain many excellent special papers.

Uses of Slag.—The slags produced in iron-making vary in composition according to the ore that is used, but are all alike in that their chief constituents are silica, lime, and alumina. From the chemist's point of view they are a kind of impure glass, and they in so far resemble glass that when rapidly cooled they are apt to fly to pieces. The uses to which slag has been longest put are the production of slag-sand by running the molten material into water and the preparation of bricks and mortar from it; and the casting of it into blocks, which are chiefly used in paving. The regular, smooth surface of these blocks is an objection to their use; but this is obviated, and the ideal cleavage surface is obtained by casting them double with a notch around the middle, where they are broken by a sharp blow. Besides being toughened and more dense, the slag, when annealed, has a strong affinity for Portland cement, and unites with it into a concrete of remarkable toughness, which is one of the best pavement materials of its class. The slag, broken by machinery, is largely used in England for road-making; for this purpose, the material should contain about equal proportions of lime and silica and seven or eight per cent of alumina. "Slag-wool," or "silicate cotton," is obtained by turning a jet of steam or an air-jet upon the stream of molten slag as it issues from the furnace. By this the slag is dispersed or broken up into countless small, bead-like particles, each of which, as it flies away, carries behind it a delicate thread of finely drawn or "spun" slag. This substance has several valuable properties. It is extremely light, and absolutely fire-proof; is a non-conductor of heat and sound; and is so porous that it will absorb large quantities of water, and readily retains the same for a considerable time. The last property is important in the use of the substance as a fire-proofing material; for, when water is pumped into a burning building, it is held by the slag-wool as by a vast sponge, and will evolve steam sufficient in itself to extinguish the flames, or at least assist powerfully in doing so. It is also an antiseptic; and this property, in conjunction with its great porosity, seems to render it specially applicable for medical purposes. Slag cements are prepared largely at several factories on the continent of Europe. To make them, the slag-sand, dried, is ground fine, mixed with slaked lime, and stamped, and the whole intimately mixed in a "homogeniser" of special construction. The slag cement is lighter than Portland cement, takes longer to set, and is cheaper. It is held in great favor in Germany, though it is not, perhaps,

so good in all respects as Portland cement. Another kind of slag—the Thomas, or "basic slag," produced in making steel—is remarkable for its richness in phosphoric acid, and is coming into use as a fertilizing material. The demand for it in Germany already exceeds the whole available production of the country, and it is imported from Great Britain and Austria.

The Formation of a New Island.—An interesting account of the newly emerged volcanic island of the Tonga group is given by Mr. J. J. Lister in the Proceedings of the Royal Geographical Society for March. It has received the name of Falcon Island, and was formed by an eruption in 1885. It was visited during its formation by some natives of the group, who say that the center of action was wholly on one side of the present island; showing that in all probability the wind played an important part in determining its position. The uncovered portion lies approximately northwest of the supposed center. It consists of two parts: a conical mound at its southern end, about one hundred and fifty-three feet high, and a flat extending to the northward, which is from ten to twelve feet above high water. There is a considerable shoal area north of the flat, but at the base of the higher portion the water deepens rapidly. The soil of the island consists of a fine-grained, dark-gray material arranged in strata. The strata are marked by difference in color and the varying thickness of the salts which have crystallized on them. The soil below the surface was found still hot; the temperature at a depth of seven feet being 100° Fahr., while at the surface it was only 74°. With the exception of two young cocoanut-trees, which seemed not very hardy, there was no vegetation but a few bunches of grass; and a moth and small sand-piper constituted the animal population. The island will probably have disappeared in a few years, unless another eruption occurs, as the waves are rapidly wearing the shore line away.



FALCON ISLAND.

The Unselfishness of Doctors.—Dr. Robert G. Eccles, in a lecture on the Evolution of Medical Science, delivered before the Brooklyn Ethical Association, pays a just tribute to the unselfishness of the medical profession. Medicine, he says, "in all ages has attracted into its ranks the most self-sacrificing members of society. As a science, it was born in altruism. To this day it offers the greatest opportunities of any department of life for the practice of the most ennobling graces of character. These constitute a primary cause of its evolution. . . . Medical men stand alone in the earth among all others, striving with their whole might to extinguish their own business. They preach temperance, virtue, and cleanliness, knowing well that, when the people come to follow their advice, their occupation, like Othello's, will be gone. They establish Boards of Health, to arrest the spread of disease, while well aware that such sanitary measures steal money from their purses. How well they succeed is shown by official statistics. . . . Nobody ever fails to send for a physician in typhus fever. Only six persons in a million die of this disease. Many more used to die when no effort toward its suppression was made. Whooping-cough seldom frightens patients, and neighborly old ladies of both sexes give advice. As a consequence, 428 in a million die of this disease. Measles, being a little more serious, needs the doctor oftener, and only 341 in a million die. Scarlet fever is still more alarming, so that medical advice is more in demand, and 222 in a million die of it. Diphtheria frightens

still more, thus assuring the doctor's presence oftener, and 168 in a million die. It is thus with every disease: the fewer it kills the more people fear it, because, if they did not fear it, they would play the fool, and give it a chance to kill more people. If bakers, grocers, dry-goods men, carpenters, tailors, and members of all other lines of business, gave as much of their labor in charity as doctors do, poverty would instantly be wiped from the earth."

Dragon-flies and Mosquitoes.—A study of practicable methods of getting rid of the nuisances of flies and mosquitoes has been set on foot by Mr. Robert H. Lamborn, of New York, aided by Mr. Morris K. Jessup; and the first fruits of the effort will shortly appear in the publication of three essays, for which prizes have been awarded. Mr. Lamborn, having been struck with the voracity of dragon-flies, and their activity in destroying mosquitoes and flies, invited attention to the investigation of their life history, and of the possibility of propagating them and applying them directly to the destruction of the noxious insects. The investigations showed that under natural conditions dragon-flies were among the most formidable enemies that the offensive insects had to encounter; but the results as to the practicability of artificial propagation and application were not encouraging. Mrs. Aaron, of Philadelphia, to whom the first prize was awarded, found that, as they do not breed in the same waters as the mosquito, they would have to be produced on an enormous scale and then taken to the mosquitoes; and that the artificial breeding of them is attended with great difficulties. Mr. Archibald C. Weeks, of Brooklyn, made experiments in breeding them artificially, and failed. They can not, moreover, be kept in houses and cities without changing their habits. Mr. William Beutenmuller, of the American Museum of Natural History, finds that dragon-flies are the natural enemy of the mosquito in its various forms and of flies, and that those insects disappear before them, but concedes the difficulty of raising them artificially. These experiments do not dispose of the question of our calling dragon-flies into service. Early efforts usually fail of the success that follows patient persistence. Much may be accomplished at once by encouraging the natural multiplication of the *Libellulidæ;* and future effort may yet develop a practicable way of raising them artificially. Other remedies are suggested which seem efficient and more immediately practicable. Among them are the cultivation of the yeast-fungus, which is fatal to flies, and attacks them frequently; fish-planting; thorough draining of spots where water can stand; and insecticides, one of the most efficient of which is kerosene. One drop of oil applied to a pool having ten square inches of surface cleared it very quickly of all life; and three dollars' worth of crude oil will be sufficient to apply to a mosquito-pond of a hundred acres five times in a season. Spraying petroleum on compost-heaps and other breeding-places is equally effective to prevent the development of flies.

Walking-Sticks and Umbrella-Handles.—The art of making walking-sticks and umbrella-handles has been greatly developed during the last forty years. Formerly, only a very few native woods and some foreign species were used for these purposes. Twenty years ago the first collection illustrating the materials used was presented by a London firm to the museum at Kew. The collection has been completed by a supplementary one from the same house, and in its later form exemplifies many points in the advance of the art. There is now hardly any limit to the material that can be turned to account for the purposes under consideration, and manufacturers keep a keen lookout for new sources of material, and novelties in sticks and fashion. The cultivation of sticks for the market has been taken up as a business at some places in continental Europe, and special attention is often paid to making the roots grow into shapely forms for the handles. A London manufacturing establishment, the floor space of which nearly covers an acre, have extensive storehouses filled with native and foreign sticks, from which stock is drawn, as it is wanted, for the shops. These, as they grow, are often very crooked, and have to be straightened. A heap of sand is provided on the top of a very hot stove, into which the sticks are plunged, and kept till they have become pliable. "The workman then take

the crooked stick while it is still hot and inserts it in a notch cut in a stout board, placed at an angle inclined from him," where he bends and strains it. When it has become perfectly straight it is thrown down to cool, after which it becomes rigid and permanent in its lines. Heat is an important element in this matter, and produces different effects on the several kinds of wood, the degree of heat necessary to straighten one kind of stick being often sufficient to spoil another kind. The same power which makes a crooked stick straight is applied to make a straight one crooked; so we find that the rigid stems of bamboos, partridge canes, and all the various kinds of sticks that are required to be curled or twisted, are by the application of heat made to assume almost any shape or form. Thus we often see ladies' sun-shade handles twisted and even tied into double knots. By far the largest number of sticks used are those known as natural sticks—that is, saplings of trees or climbing plants, when the roots have sufficient character to form handles or knots. These are always more in demand than sticks cut from solid wood. The finished canes are sometimes mounted with precious metals, stones such as onyx, jasper, marbles, even precious stones, ivory, and horns of all kinds.

Microscopic Structure of Stone. — The investigation of the minute structure of minerals and rocks is recommended by Dr. H. Hensoldt as the application most eminently adapted to afford pleasure and satisfaction to the lover of the microscope. It presents an exceeding complexity of forms and a most wonderful display of colors, and offers a field as yet almost untrodden and affording endless opportunities for research. "Especially striking and lovely is the appearance of many of the volcanic or igneous rocks, when reduced to thin sections, and examined under the microscope. The dullish green lava, called pitch-stone, which is found in dikes on the island of Arran, on the west coast of Scotland, exhibits under the microscope whole forests of fern-trees, garlands, leaves, and flowers of marvelous magnificence. A certain granite from Cornwall contains needle-shaped crystals of tourmaline, radiating star-like from a common center. Basalts, obsidians, porphyries, serpentines from various localities, show labyrinths of multicolored crystals resembling rows of pillars, turreted castles, and fairy caves, glowing in all the tints of the rainbow. The sedimentary or stratified rocks, while they can not under the microscope equal their Plutonic rivals in brilliancy of color or gorgeousness of crystalline display, make up for this deficiency by other features of interest, compensating the inquirer with revelations of a different character, but none the less remarkable. Many marbles and limestones are found to be literally composed of foraminifera, the tests of rhizopods, resembling tiny shells of the most delicate and beautiful forms. . . . Thin sections of almost any piece of flint exhibit under the microscope quite a little world of curious organic remains, such as sponge spicules, xanthidia, small fragments of coral, and the foraminifera already mentioned, furnishing very strong evidence that the flints are silicified fossil sponges. . . . This branch of study, though barely thirty years old, has already contributed such a vast deal of new information to natural science that it has, in more than one respect, revolutionized our old-fashioned conceptions of geological research."

Asphalt in Building Construction.—Some interesting examples of recent new uses of this substance are given in a paper with the above title by Mr. T. H. Boorman, published in Architecture and Building. The writer says: "From the cellar to the roof, asphalt has been used where the requirements have been water and fire proof floors. Its principal merits are its *utter imperviousness to water or damp*, and its *elasticity*, whereby cracking, especially from the influence of frost, is prevented. Also from a *sanitary* point of view the advantages of asphalt are incontestable, for it possesses great antiseptic properties, and, owing to its having no joints, it is impossible for particles of animal or vegetable matter to lodge in crevices and putrefy. It greatly promotes cleanliness, as it can be easily washed, and for this reason is invaluable in hospitals, breweries, stables, etc. Asphalt first appears in your specifications as under the item of 'damp course.' It is advisable to lay throughout the walls on the grade of the cellar-floor half an inch

of asphalt, with a lap of about two inches on the inside, so allowing a connection with the asphalt finish of the cellar-floor and hermetically sealing the house from damp, noxious gases, and vermin. In residences you will probably consider you have done your duty by asphalt if you have thus specified for your damp course and cellar-floor; in the latter, by the way, three fourths of an inch of asphalt on three inches of hydraulic cement concrete will serve the desired purpose of a durable damp-proof floor. The yards of city residences are now frequently laid with asphalt, the material being peculiarly adapted to the roller-skates and tricycles of the younger members of a family. From a building, then, in which only one floor, the cellar, is required to be of asphalt, let us consider where every floor and the roof can be of this material; in printing-houses, lithographing establishments, breweries, sugar-refineries, and slaughter-houses, you will often find this material used throughout. This year, however, sees a novelty in construction with asphalt. Theophilus P. Chandler, Jr., architect, of Philadelphia, is using rock asphalt on every floor of a large apartment-house; the carpets will lie on the asphalt, being fastened down to narrow strips of wood set against the partitions when the asphalt is laid. Now, I fancy I hear you say, 'Well, asphalt is not pleasant in appearance.' Why, gentlemen, the mayor's private office in the great City Buildings of Philadelphia, the greatest municipal edifice in the country, is laid with asphalt with a border of colored tiles."

Some People of New Guinea.—Of the natives of the neighborhood of the Owen Stanley Range, New Guinea, Sir William MacGregor says that their features are decidedly good, and their faces indicate more character and strength than those of the average coast men. The cheek-bones in some are rather broad and prominent. The nose is generally of the Semitic type. They possess all the volubility of the Papuan race, and are less shy than tribes that have seen more of white men, but are apparently superstitious and easily frightened. "They informed us that they used both the bow and the spear, but we never saw one of them with a weapon, and I could not induce them to bring any to camp; not, as it appeared, as if they mistrusted us, but seemingly doubting whether it would not be misunderstood should any of them with arms in their hands meet any of our party away from camp." They always left the camp before nightfall. They would exchange food for salt, beads, and cutlery, but did not care much for tobacco, growing a good quality of their own. They also cultivate peas, beans, yams, sweet potatoes, and several varieties of bananas, and have abundant food.

Origin of the American Indian.—Prof. F. W. Putnam, in an address before the Archæological Association of the University of Pennsylvania, said, in reference to the origin of our Indians, that two well-defined groups of races are found in America. They have entirely different-shaped skulls. One group starts in Mexico and reaches to Peru. They are a short-headed people. They extended across from Mexico along the Gulf coast, up the Mississippi Valley and along the southern portion of the Atlantic coast, not crossing the Alleghanies and not being found north of the Great Lakes. They were the people that built the mounds and founded the civilization of Mexico and Peru. Another race, a long-headed people, inhabited the northern part of the country, and were the authors, among other articles, of certain objects found in Wisconsin. These two races have met and mingled, and the result is the American Indian.

Results of M. Pasteur's Anti-rabic Treatment.—M. L. Perdrix's report of the anti-rabic vaccinations at the Pasteur Institute since 1886 divides the cases treated into three classes: those of persons bitten by dogs ascertained experimentally to be mad; of persons bitten by dogs decided by veterinary examination to be mad; and of persons bitten by dogs supposed to be rabid. The proportion of deaths after treatment is shown by the tables to be very small; for a total of 7,893 cases of all the classes, it was 0·67 per cent; but the proportion has decreased from year to year; it having been 0·94 per cent in 1886, 0·73 in 1887, 0·55 in 1888, and 0·33 in 1889. The decrease is attributed to a better appreciation of the gra-

ity of the cases and a more judicious proportioning of the measure of treatment to that feature. The gravity of the case appears to vary somewhat according to the part of the body that is bitten. The most dangerous bites were in the head, with which the mortality was 2·36 per cent; next were the hands, 0·69 per cent; and last the body and limbs, 0·27 per cent. The inferior gravity of the last class of bites may, perhaps, be attributed to the action of the clothing in wiping the animal's teeth.

The Unexplored Regions of Canada.—It is commonly supposed that all parts of Canada have been explored and are known. Mr. G. M. Dawson thinks that this opinion is not correct, and that the clearness of the maps, on which it is chiefly founded, is due to their makers having assumed for regions of considerable extent what has not been verified. Probably but little of the regions which are really unknown is agriculturally or climatically attractive; but they may contain mineral wealth, and some of them may in time have value for cultivation. In marking out the districts which he regards as unexplored, the author takes no notice of comparatively small tracts of country lying between explored regions, or of any having an area of less than 7,500 square miles; and he also omits the arctic islands lying to the north of the continent. With these limitations he enumerates and defines sixteen distinct regions in the Dominion concerning which definite and satisfactory information is wanting, varying in area from 7,500 square miles to 289,000 square miles. In all, it may be stated that "while the entire area of the Dominion is computed at 3,470,257 square miles, about 954,000 square miles of the continent alone, exclusive of the inhospitable detached arctic portions, is for all practical purposes entirely unknown. In this estimate the area of the unexplored country is reduced to a minimum by the mode of definition employed. Probably we should be much nearer the mark in assuming it as about one million square miles, or between one third and one fourth of the whole. Till this great aggregate of unknown territory shall have been subjected to examination, or at least till it has been broken up and traversed in many directions by exploratory and survey lines, we must all feel that it stands as a reproach to our want of enterprise and of a justifiable curiosity. In order, however, to properly ascertain and make known the natural resources of the great tracts lying beyond the borders of civilization, such explorations and surveys as are undertaken must be of a truly scientific character."

Crystallization seen in the Act.—The process of crystallization as observed under the microscope is described by Dr. H. Hensoldt in a paper on crystallogenesis. The commencement of the operation is always signaled by the sudden appearance, in the previously clear and colorless field, of innumerable dark points, which, in an incredibly short time, augment in volume, till a diameter of perhaps $\frac{1}{700}$ of a millimetre is reached. It is then observed that the particles are spherical in outline, and that their darkness is only an optical illusion, caused by a broad diffraction-ring, for in reality they are quite transparent. They are evenly distributed over the field, and their "growth"—a kind of spontaneous swelling, which can be plainly followed—is uniform and simultaneous. The particles then appear to become suddenly endowed with polarity; they change their positions, roll about like billiard-balls in every direction, yet always in straight lines. For a moment all seems confusion, but behold! some invisible "floor-master" is asserting his authority, and in another instant we have the first manifestation of a symmetry destined to culminate in that perfect crystalline regularity which has excited the wonder of all ages. The globules, originally scattered all over the field, are now arranged in lines or rows, like so many strings of beads. Some of these rows consist of only three or four globules, in others we can count ten, fifteen, twenty, or more; and it would seem as if each spherical body was surrounded by a delicate film or pellicle, which prevents the dissipation of the internal molecular forces. A series of rapid changes is now inaugurated, which can be followed only with the greatest difficulty. The globules in each line, by a sudden and simultaneous movement, unite and form solid rods, and there are grounds for believing that this solidification is due to the ruptur-

ing of the mysterious pellicle referred to. Within a quarter of a second after the formation of the rods (which are of uniform thickness, however much they may vary in length), we observe a general commotion among them. Each now appears to act as a separate bar-magnet, and while some unite at right angles, others range themselves in close contact side by side, and form a symmetrical wall. Layer is piled on layer; each little rod falls mechanically into its proper place; and before we have time to realize the strangeness of the spectacle, the field is studded with little cubes of exquisite brilliancy. What we have seen here in an evaporating drop of chloride of sodium may be observed in any other saline substance which we allow to crystallize under the microscope, with the sole difference that the diameter of the globules and the form of the ultimate crystals vary according to the nature of the substances employed.

The Genuineness of the "Nampa Image."—The Boston Society of Natural History had a discussion a few months ago respecting the "Nampa image," or the little human figure of clay that was found in boring a well at Nampa, Idaho, in August, 1889. Prof. Wright produced letters and statements substantiating the genuineness of the discovery and certifying to the eye-witnesses of the fact as men of unimpeachable intelligence and integrity. A report by Mr. Albert Allen Wright, on his examination of the image as to the material of which it is made and its appearance, stated conclusions favorable to its antiquity. Prof. G. F. Wright regarded the direct evidence as of as high order as could well be obtained. "There was no sensational publication in the papers, nor has there been any suggestion of mercenary motives. There were no archæologists or scientific men on the ground to be humbugged. Apparently the image would have disappeared and dropped out of notice but for the fortunate chance which brought it to the attention of Mr. Adams, when his own mind was interested in that class of subjects. The evidence is most direct as to the impossibility of the image's having fallen into the well from the surface, or of its having been put in by design." Much weight is also attached to Prof. F. F. Jewett's opinion as to the character of the iron oxide on the image. "It seems in the highest degree improbable," Prof. Wright adds, "that any one should have manufactured such an object on the spot, and been so successful in meeting all the conditions present. I am, therefore, prepared to accept without further question the genuineness of the image, and shall look for further confirmation as time elapses." Prof. Putnam spoke of natural evidences which the image afforded of its age. Prof. H. W. Haynes said that he regarded the image as a most important evidence of the antiquity of man in America.

NOTES.

Prof. J. W. Spencer has extended the observations of Mr. G. K. Gilbert on the old beach surrounding Lake Ontario at a distance of several miles from the shore of the present lake. He has traced it along the Canadian side, and at the eastern end, where Mr. Gilbert had not been. For the ancient body of water that occupied the basin bounded by this beach, he proposes the name Lake Iroquois. The gravel ridges forming the several portions of this beach were used by the Indians for their trails, as they afforded dry pathways through a country elsewhere often muddy. The fact that some parts of this beach are higher than others is explained by the warping of the crust since the beach was formed.

It is contended by Mr. Alexander Bowbronicki that an unhealthy town has no other meaning than a proportionate accumulation of decaying or putrescible matter. Thus, in Manchester, England, the causes of mischief are overcrowded streets, badly kept; surface impurities in streets, yards, and corners; and sewers of such construction as admits of their structure becoming sodden and of their charging the surrounding subsoil with filth, whereby the atmosphere is contaminated by the escape of the foul air through the ventilating holes. The author believes that sewers are to protect the subsoil against contamination from the surface and to maintain as steadily as possible the level of the subsoil water, rather than to remove superficial and closet foulness; and that that should be disposed of by the pail system.

A complete account of Prjevalski's zoological observations and discoveries during his expeditions to central Asia is in course of publication in Russian and German text, at the expense of the Imperial Crown Prince Nicholas of Russia.

DR. J. WALTER FEWKES has described in The American Naturalist some specimens of excavations made in rocks by sea-urchins, which he observed at Grand Manan, New Brunswick. Other places where such excavations have been found are Florida, the West Indies, Panama, California, the Mediterranean, coasts of the British Isles and France, and Australia. The holes, which are occupied by the animals, are never deeper than the thickness of the urchins' bodies, and are very smooth. It has been suggested that the holes are worn by the spines of the animal, or perhaps chiseled out by its teeth, and Dr. Fewkes adds that perhaps motions of the animals caused by waves aid the process of erosion. Another recent paper by Dr. Fewkes describes some Californian *Medusæ*, with plates.

A WRITER in the North China Herald of Shanghai asserts that the climate of Asia is growing colder, and its tropical animals are slowly retreating southward. In proof of this he quotes evidences, historical and referential, of the former existence of elephants, tigers, and leopards in China. Tigers and leopards are, however, not yet extinct in China, and are common enough in Corea. The bamboo, it is said, formerly grew naturally in parts of the country where it now has to be taken care of.

THE Central Park Menagerie had 907 animals on exhibition during 1889, representing 242 species, 164 genera, and 71 families. The most notable additions to the collection were, by gift or exchange, a three-toed sloth, an American civet-cat, very seldom seen alive in zoölogical collections, and a pair of young elks; and by birth a sea-lion, two nylghaie antelopes, and one hippopotamus. The last died four days after birth. The principal cause of death among the animals was congestion of the lungs.

"To get rid of the timber," the answer given to an inquiry from the Michigan State Forestry Commission respecting the timber policy of the State of Arkansas, is made by Mr. William Little the text of a letter to the Montreal Board of Trade on the importance of preserving the timber. The interests of the United States and Canada in this matter are substantially the same. Having shown that the forests of the continent are on the verge of extinction, and having pointed out the lesson that the people of the United States will shortly be taught, if our political bosses impose a restrictive duty on Canadian lumber, the author warns his countrymen that if they continue stocking our saw-mills with logs taken from this already too scanty supply, and keep warring on their forests, they will soon be able to "get rid of their timber," and to get rid at the same time of the most valuable property they ever had or may ever expect to have in their country.

A GROUP of papers from the Journal of Mycology on The Treatment of Plant Disease is published in a separate pamphlet by the Section of Vegetable Pathology of the United States Department of Agriculture. The relation of Mr. A. A. Crozier's experiments on the effects of certain fungicides upon the vitality of seeds shows that soaking in blue vitriol and in copperas tends to retard germination. Prof. Byron D. Halsted contributes an investigation of the scald and gall fungus of the cranberry. Other papers, by different authors, relate chiefly to other fungoid diseases and to the qualities of fungicides.

SIX scholarships have been established in the Missouri Botanic Garden to provide six years' courses of theoretical and practical instruction for young men desirous of becoming gardeners.

ALTHOUGH there is a wide enough field for platinum-plating in the making of various kinds of instruments and apparatus, such great difficulties attend the process that it has never been made a commercial success. In the first place, the metal tends to separate from its salts in the spongy form instead of forming a firm, hard coating. Then, too, platinum is so insoluble that plates of it can not be used for keeping up the strength of the bath. Mr. William H. Wahl has communicated to the Franklin Institute a method of depositing platinum by which these difficulties are largely avoided. For keeping up the strength of the bath he uses platinum hydrate, which dissolves freely in aqueous solutions of the alkaline hydrates, forming platinates. These platinate solutions conduct electricity freely and yield bright, reguline, and adherent deposits of the metal.

ON the French coast of Croisic may be seen thousands of little sea-urchins ensconced in cavities in the granite rock, the openings of which are too small to permit their ingress or exit. The animals, it is not doubted, make and widen the holes for themselves, but the question how has not been answered. Chemical solution of the rock does not seem possible, as no sufficiently strong acid is found in the animal. M. John has recently explained it by mechanical action. With the so-called lantern of Aristotle, a curious formation with which the animal breaks up the hard substances on which it feeds, it probably bites the rock; the sucker-feet are attached, and a rotary motion is imparted to the body, the spines and the lantern slowly wearing down the surface of the rock.

A REPORT of the first systematic attempt to determine whether beets can be raised successfully for sugar in Nebraska is given in Bulletin No. 13 of the State Agricultural Experiment Station. Beets had been raised

on the Industrial College farm that yielded over fifteen per cent of sugar, when, in the spring of 1888, the people around Grand Island undertook to demonstrate that beets could be raised there rich enough in sugar to warrant investment in a sugar plant. The result was satisfactory, and the experiment was extended through the whole State for the season of 1889. The results are detailed in the Bulletin.

THE natural result has followed the offer by the Government of India of rewards for the heads of snakes. The Chief Commissioner of the Central Provinces reports that the natives there are beginning to breed and raise poisonous snakes for the sake of getting the head-money offered.

A MONUMENT to M. J. C. Houzeau was to be unveiled at Mons on the 2d of June.

OBITUARY NOTES.

SIR EDWIN CHADWICK, whom an English paper styles the "father of modern sanitary science," died in London, July 5th, ninety years old. He was born in 1800, near Rochdale, of an old family, famous for the long lives attained by some of its members. He was admitted as a barrister in 1830, and also engaged in literary work; and, from the appearance of an article on Life Assurance in the Westminster Review, his life is most largely a record of efforts to improve the conditions of health. Among the direct or indirect fruits of his activity were the establishment of industrial schools for destitute children; provisions for the care of aged poor and infirm; reforms in workhouse systems; the ten-hour law; the half-time system for children; the first sanitary commission; and the establishment of the Registrar-General's office. He was a permanent Commissioner on the Local Government Board; did good service in Crimean and Indian questions; and was President at different times of Sanitary Congresses, of the Society of Sanitary Inspectors, and of the Economical Section at meetings of the British Association. On the 2d of March, 1889, his ninetieth birthday, he was given a dinner by the Association of Sanitary Inspectors. A little before this time he was made a Knight of the Bath.

GENERAL JOHN CHARLES FRÉMONT died in New York, July 13th, in his seventy-eighth year. The political and military incidents of his later life have somewhat obscured the recollection of what he did for the advancement of knowledge in the earlier period of his career. The region of the Rocky Mountains was then practically unknown. He undertook in 1842 to explore it and open an overland route to the Pacific. In 1843 he led an expedition up the valley of the Platte, explored the Great Salt Lake, etc., to Fort Vancouver, near the mouth of the Columbia River. On the return journey he came back through the Great Basin and the South Pass. In 1845 he conducted an expedition to explore the Sierra Nevada, in California, in connection with which he became engaged in military and political complications. In 1853 he led a party at his own expense to the Pacific, by a new route, near latitude 38° north. Full accounts of his discoveries were published in his reports to the Government and in other books; and though the regions he visited are familiar enough now, the works had then all the freshness of novelty. For his services as an explorer he received gold medals from the King of Prussia and the Royal Geographical Society.

SIR WARINGTON SMYTH, Professor of Mining at the Royal School of Mines, Jermyn Street, London, died June 19th, in the seventy-third year of his age. He was born in Naples; spent his early boyhood in Italy; was sent to the English schools and was graduated from Cambridge; took a prominent position as a scientific authority on mining; was appointed in 1851, on the nomination of Sir Henry De la Beche, lecturer on mineralogy and mining; was made mineral surveyor to the Duchy of Cornwall and inspector of crown mines; and was invariably consulted by the Government on mining matters. His contributions to geological journals, reports, etc., were numerous, but have not been collected. He was the author of a Rudimentary Treatise on Coal and Coal-Mining, and of a Book of Travels.

MR. W. KITCHEN, for fifteen years Hunterian Professor of Comparative Anatomy in the Royal College of Surgeons, and President of the Royal Microscopical Society in 1871 and 1872, died early in July. He was distinguished by his investigations on the minute foraminifera and the morphology of the vertebrate skull.

PATRICK BARRY, one of the most distinguished American horticulturists, died at his home in Rochester, N. Y., in June. He was born in Belfast, Ireland, in 1816, and came to America when twenty years old. He was especially interested and efficient in pomology, and his Fruit Garden has long been one of the most valuable standard works on that subject. He was for more than thirty years President of the Western New York Horticultural Society, and was a member of the Board of Control of the State Agricultural Experiment Station. He was for several years editor of The Horticulturist, when it was the leading periodical in that branch, and afterward horticultural editor of the Genesee Farmer. "As an author and editor," says Garden and Forest, "he always had some instructive message, and he always delivered it in a way that compelled attention"; and "it might be said that his influence has reached every orchard and garden of the country."

RENÉ DESCARTES.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

X. THE FALL OF MAN AND ANTHROPOLOGY.

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PART II.

WE have seen that, closely connected with the main lines of investigation in Archæology and Anthropology, there were other researches throwing much light on the entire subject. In a previous chapter we saw especially how Lafitau and Jussieu were among the first to collect and compare facts bearing on the natural history of man, gathered by travelers in various parts of the earth, thus laying foundations for the science of Comparative Ethnology. It was soon seen that Ethnology had most important bearings upon the question of the material, intellectual, moral, and religious evolution of the human race; in every civilized nation, therefore, appeared eminent men who began to study the characteristics of various groups of men as ascertained from travelers, and to compare the results thus gained with each other and with those obtained by Archæology.

Thus, more and more clear became the evidences that the tendency of the race has been upward from low beginnings. It was found that groups of men still existed possessing characteristics of those in the early periods of development to whom the drift and caves and shell-heaps and pile-dwellings bear witness; groups of men using many of the same implements and weapons, building their houses in the same way, seeking their food by the same means, enjoying the same amusements, going through the same general stages of culture; some being in a condition corresponding to the earlier, some to the later periods.

From all sides thus came evidence that we have still upon

the earth examples of all the main stages in the development of human civilization; that from the period when man appears little above the brutes, and with little if any religion in any accepted sense of the word, these examples can be arranged in an ascending series leading to the highest planes which humanity has reached; that philosophic observers may among these examples study existing beliefs, usages, and institutions back through earlier and earlier forms until, as a rule, the whole evolution can be easily divined if not fully seen. Moreover, the basis of the whole structure became more and more clear; the declaration that "the lines of intelligence have always been what they are, and have always operated as they do now—that man has progressed from the simple to the complex, from the particular to the general."

As this evidence from Ethnology became more and more strong, its significance to Theology aroused attention, and naturally most determined efforts were made to break its force. On the Continent the two great champions of the Church in this field were De Maistre and De Bonald; but the two attempts which may be especially recalled as the most influential among English-speaking peoples were those of Whately, Archbishop of Dublin, and the Duke of Argyll.

First in the combat against these new deductions of science was Whately. He was a strong man, caring little for conventionalities, whose breadth of thought and liberality in practice deserved all honor; but these very qualities drew upon him the distrust of his orthodox brethren, and while his writings were powerful in the first half of the present century to break down many bulwarks of unreason, he seems to have been constantly in fear of losing touch with the Church, and therefore to have promptly attacked some scientific reasonings, which, had he been a layman, not holding a brief for the Church, he would probably have studied with more care and less prejudice. He was not slow to see the deeper significance of Archæology and Ethnology in their relations to the theological conception of "the fall," and he set the battle in array against them.

His contention was, to use his own words, that "no community ever did or ever can emerge unassisted by external helps from a state of utter barbarism into anything that can be called civilization"; and that, in short, all imperfectly civilized, barbarous, and savage races are but fallen descendants of races more fully civilized. This view was urged with his usual ingenuity and vigor; but the facts proved too strong for him: they made it clear, first, that many races were without simple possessions, instruments, and arts which never, probably, could have been lost if once acquired—as, for example, pottery, the bow for shooting, various domesticated animals, spinning, the simplest principles of agriculture, house-

hold economy, and the like; and, secondly, it was shown as a simple matter of fact that various savage and barbarous tribes *had* raised themselves by a development of means which no one from outside could have taught them; as in the cultivation and improvement of various indigenous plants, such as the potato and Indian corn among the Indians of North America; in the domestication of various animals peculiar to their own regions, such as the llama among the Indians of South America; in the making of sundry fabrics out of materials and by processes not found among other nations, such as the bark cloth of the Polynesians, and in the development of weapons peculiar to sundry localities, but known in no others; such as the boomerang in Australia.

Most effective in bringing out the truth were such works as those of Sir John Lubbock and Tylor; and so conclusive were they, that the arguments of Whately were given up as untenable by the other of the two great champions above referred to, and an attempt was made by him to form the diminishing number of thinking men supporting the old theological view on a new line of defense.

This second champion, the Duke of Argyll, was a man of much knowledge and strong powers in debate, whose high moral sense was amply shown in his adhesion to the side of the American Union in the struggle against disunion and slavery, despite the overwhelming majority against him in the high aristocracy to which he belongs. As an honest man and close thinker, the duke was obliged to give up completely the theological view of the antiquity of man. The whole biblical chronology as held by the universal Church, "always, everywhere, and by all," he sacrificed, and gave all his powers in this field to support the theory of "the fall." *Noblesse oblige;* the duke and his ancestors had been for centuries the chief pillars of the Church of Scotland, and it was too much to expect that he could break away from a tenet which forms really its "chief corner-stone."

Acknowledging the weakness and insufficiency of Archbishop Whately's argument, the duke took the ground that the lower, barbarous, savage, brutal races were the remains of civilized races which, in the struggle for existence, had been pushed and driven off to remote and inclement parts of the earth where the conditions necessary to a continuance in their early civilization were absent; that, therefore, the descendants of primeval, civilized men degenerated and sank in the scale of culture. To use his own words, the weaker races were "driven by the stronger to the woods and rocks," so that they became "mere outcasts of the human race."

In answer to this, while it was conceded, first, that there have been examples of weaker tribes sinking in the scale of culture

after escaping from the stronger into regions unfavorable to civilization, and, secondly, that many powerful nations have declined and decayed, it was shown that the men in the most remote and unfavorable regions have not always been the lowest in the scale; that men have been frequently found "among the woods and rocks" in a higher state of civilization than on the fertile plains, such examples being cited as Mexico, Peru, and even Scotland; and that while there were many examples of special and local decline, overwhelming masses of facts point to progress as a rule.

The improbability, not to say impossibility, of many of the conclusions arrived at by the duke appeared more and more strongly as more became known of the lower tribes of mankind. It was necessary on his theory to suppose many things which our knowledge of the human race absolutely forbids us to believe: for example, it was necessary to suppose that the Australians or New Zealanders, having once possessed so simple and convenient an art as that of the potter, had lost every trace of it; and that the same tribes, having once had so simple a means of saving labor as the spindle or small stick weighted at one end for spinning, had given it up and gone back to twisting threads with the hand. In fact, it was necessary to suppose that one of the main occupations of man from "the beginning" had been the forgetting of simple methods, processes, and implements, which all experience in the actual world teaches us are never entirely forgotten by peoples who have once acquired them.

Some leading arguments of the duke were overthrown by simple statements of fact. Thus, his instance of the Eskimo as pushed to the verge of habitable America, and therefore living in the lowest depths of savagery, which even if it were true by no means proved a general rule, was deprived of its force by the simple fact that the Eskimo are by no means the lowest race on the American continent, and that various tribes far more centrally and advantageously placed, as, for instance, those in Brazil, are really inferior to them in the scale of culture. Again, his statement that "in Africa there appear to be no traces of any time when the natives were not acquainted with the use of iron" is met by the fact that from the Nile Valley to the Cape of Good Hope we find, wherever examination has been made, the same early stone implements which in all other parts of the world precede the use of iron, some of which at least would not have been made had their makers possessed iron. The duke also tried to show that there were no distinctive epochs of stone, bronze, and iron, by adducing the fact that some stone implements are found even in some high civilizations. This is indeed a fact. We find some few European peasants to-day using stone mallet-heads; but this

proves simply that the old stone mallet-heads have survived as implements cheap and fairly effective.

The argument from Comparative Ethnology in support of the view that the tendency of mankind is upward has received strength from many sources. Comparative Philology shows that in the less civilized, barbarous, and savage races childish forms of speech prevail;—frequent reduplications and the like, of which we have survivals in the later and even in the most highly developed languages. In various languages, too, we find relics of ancient modes of thought in the simplest words and expressions used for arithmetical calculations. Words and phrases for this purpose are frequently found to be derived from the words for hands, feet, fingers, and toes, just as clearly as in our own language some of our simplest measures of length are shown by their names to have been measures of parts of the human body, as the cubit, the foot, and the like, and therefore to date from a time when exactness was not required. To add another out of many examples, it is found to-day that various rude nations go through the simplest arithmetical processes by means of pebbles. Into our own language through the Latin has come a word showing that our distant progenitors reckoned in this way. The word *calculate* gives us an absolute proof of this. According to the theory of the Duke of Argyll, men ages ago used pebbles (calculi) in performing the simplest arithmetical calculations because we to-day "*calculate*." No reduction to absurdity could be more thorough. The simple fact must be that we "calculate" because our remote ancestry used pebbles in their arithmetic.

So, too, Comparative Literature and Folk-Lore show childish modes of viewing nature and childish ways of expressing the relations of man to nature among peoples of a low culture to-day, such as clearly survive from a remote ancestry; noteworthy among these are the beliefs in witches and fairies, and multitudes of popular and poetic expressions in the most civilized nations.

So, too, Comparative Ethnography, the basis of Ethnology, shows in contemporary barbarians and savages a childish love of playthings and games, of which we have many survivals.

All these facts, which were at first unobserved, or observed as a matter of no significance, have been brought into connection with a fact in Biology acknowledged alike by all important schools, by Agassiz on one hand and by Darwin on the other—namely, as stated by Agassiz, that "the young states of each species and group resemble older forms of the same group," or, as stated by Darwin, that "in two or more groups of animals, however much they may at first differ from each other in structure and habits, if they pass through closely similar embryonic stages, we may

feel almost assured that they have descended from the same parent form, and are therefore closely related."*

The history of Art, especially as shown by Architecture, in the noblest monuments of the most enlightened nations of antiquity, also gives abundant proofs of this same upward tendency from the rudest and simplest beginnings. Many columns of early Egyptian temples or tombs are but bundles of Nile reeds slightly conventionalized in stone: the temples of Greece, including not only the earliest forms, but the Parthenon itself, while in parts showing an evolution out of Egyptian architecture, exhibit frequent reminiscences and even imitations of earlier constructions in wood: the mediæval cathedrals, while evolved out of Roman and Byzantine structures, constantly show unmistakable survivals of prehistoric construction.†

So, too, History has come in, illustrating the unknown from

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* For the stone forms given to early bronze axes, etc., see Nilsson, Primitive Inhabitants of Scandinavia, London, 1868, Lubbock's Introduction, p. xxxi; and for Plates, see Lubbock's Prehistoric Man, chapter ii; also Cartailhac, Les Âges Préhistoriques de l'Espagne et du Portugal, p. 227; also Keller, Lake Dwellings; also Troyon, Habitations Lacustres; also Boyd Dawkins, Early Man in Great Britain, p. 292; also Lubbock, p. 6; also Lyell, Antiquity of Man, chap. ii. For the cranogs, etc., in the north of Europe, see Munro, Ancient Scottish Lake Dwellings, Edinburgh, 1882. For mounds and greater stone constructions in the extreme south of Europe, see Cartailhac's work on Spain and Portugal above cited, Part III., chap. iii. For the source of Mr. Southall's contention, see Brugsch, Egypt of the Pharaohs. For the two sides of the question whether in the lowest grades of savagery there is really any recognition of a superior power, or anything which can be called, in any accepted sense, religion, compare Quatrefages with Lubbock, in works already cited. For a striking but rather *ad captandum* effort to show that there is a moral and religious sense in the very lowest Australian tribes, see one of the discourses of Archbishop Vaughan on Science and Religion. For one out of multitudes of striking and instructive resemblances in ancient stone implements and those now in use among sundry savage tribes, see comparison between old Scandinavian arrow-heads and those recently brought from Tierra del Fuego, in Nilsson as above, especially in Plate V. For a brief and admirable statement of the arguments on both sides, see Sir J. Lubbock's Dundee paper, given in the appendix to the American edition of his Origin of Civilization, etc. For the general argument referred to between Whately and the Duke of Argyll on one side and Lubbock on the other, see Lubbock's Dundee paper as above cited; Tylor, Early History of Mankind, especially p. 193; and the Duke of Argyll, Primeval Man, Part IV. For difficulties of savages in Arithmetic, see Lubbock, Origin of Civilization, New York, 1889, pp. 459 *et seq.* For a very temperate and judicial view of the whole question, see Tylor, Early History of Mankind, chap. vii., especially pp. 188–191, also chap. xiii. For a brief summary of the scientific position regarding the stagnation and deterioration of races, resulting in the statement that such deterioration "in no way contradicts the theory that civilization itself is developed from low to high stages," see Tylor, Anthropology, chap. i.

† For striking examples of the testimony of language to upward progress, see Tylor, chap. xii; as to evolution in Architecture, and especially of Greek forms and ornaments out of Egyptian and Assyrian, with survivals in stone architecture of forms obtained in Egypt when reeds were used, and in Greece when wood construction prevailed, see Fergusson's Hand-Book of Architecture, vol. i, pp. 100, 228, 233, and elsewhere; also Ottfried Müller, Ancient Art and its Remains, English translation, London, 1852, pp. 219, *passim*.

the known—the development of man in the prehistoric period from his development within historic times. Nothing is more evident from history than the fact that weaker bodies of men driven out by stronger do not necessarily relapse into barbarism, but frequently rise, even under the most unfavorable circumstances, to a civilization equal or superior to that from which they have been banished. Out of very many examples showing this law of upward development, a few may be taken as typical. The Slavs, who sank so low under the pressure of stronger races that they apparently gave the modern world a new word to express the most hopeless servitude, have developed powerful civilizations peculiar to themselves; the barbarian tribes who, ages ago, took refuge amid the sand-banks and morasses of Holland, have developed one of the world's leading centers of civilization; the wretched peasants who about the fifth century took refuge from invading hordes among the lagoons and mud-banks of Venetia, developed a power in art, arms, and politics which is among the wonders of human history; the Puritans, driven from the civilization of great Britain to the unfavorable climate, soil, and circumstances of early New England; the Huguenots, driven from France, a country admirably fitted for the highest growth of civilization, to various countries far less fitted for such growth; the Irish peasantry driven in vast numbers from their own island to other parts of the world, on the whole less fitted to them—all are proofs that, as a rule, bodies of men once enlightened, when driven to unfavorable climates and brought under the most depressing circumstances, not only retain what enlightenment they have, but go on increasing it. Besides these, we have such cases as those of criminals banished to various penal colonies from whose descendants has been developed a high civilization; and of pirates, like those of the Bounty, whose descendants, in a remote Pacific island, became sober, steady citizens; thousands of examples show the prevalence of this same rule—the rule that men in masses do not forget the main gains of their civilization, and that their tendency is upward.

Another class of historic facts also testifies in the most striking manner to this same upward tendency—the decline and destruction of various civilizations brilliant but hopelessly vitiated. These catastrophes are seen more and more to be but steps in this development. The crumbling away of the great ancient civilizations based upon despotism, whether the despotism of monarch, priest, or mob—the decline and fall of Roman civilization, for example, which, in his most remarkable generalization, Guizot has shown to have been necessary in the development of the richer civilization of modern Europe; the terrible struggle and loss of the Crusades, which once appeared to be a mere catastrophe, but

are now seen to have brought on the downfall of feudalism, and the centralizing, civilizing monarchical period; the French Revolution, once thought a mere outburst of diabolic passion, but now seen to be a transition from the monarchical to the constitutional epoch—all show that even wide-spread deterioration and decline, even indeed the greatest political and moral catastrophes, so far from leading to a fall of mankind, tend in the long run to raise humanity to higher planes.

Thus, then, Anthropology and its handmaids Ethnology, Philology, and History, have wrought out, beyond a doubt, proofs of the upward evolution of humanity since the appearance of man upon our planet.

And these researches have not been confined to progress in man's material condition. Far more important evidences have been found of upward evolution in his family, social, moral, intellectual, and religious relations. The light thrown on this subject by such men as Lubbock, Tylor, Herbert Spencer, Buckle, Draper, Max Müller, and a multitude of others, despite mistakes, haltings, stumblings, and occasional following of delusive paths, is among the greatest glories of the century now ending. From all these investigators in their various fields, holding no brief for any system sacred or secular, but seeking truth as truth, comes the same general testimony of the evolution of higher out of lower. The process has been indeed slow and painful, but this does not prove that it may not become more rapid and less fruitful in sorrow as humanity goes on.*

While, then, it is not denied that many instances of retrogression can be found, the consenting voice of unbiased investigators in all lands has declared more and more that the beginnings of our race must have been low and brutal, and that the tendency has been upward. To combat this conclusion by examples of decline and deterioration here and there, has become impossible: as well try to prove that, because in the Mississippi there are eddies in which the currents flow northward, there is no main stream flowing southward; or that, because trees decay and fall, there is no law of upward growth from germ to trunk, branches, foliage, and fruit.

A very striking evidence that the theological theory had become untenable was seen when its main supporter in the scientific field, Von Martius, in the full ripeness of his powers, publicly declared his conversion to the scientific view.

Yet, while the tendency of enlightened human thought in recent times is unmistakable, the struggle against the older view is

* As to the good effects of migration, see Waitz, Introduction to Anthropology, London, 1863, p. 345.

not yet ended. The bitterness of the Abbé Hamard in France has been carried to similar and even greater extremes among sundry Protestant bodies in Europe and America. The simple truth of history makes it a necessity, unpleasant though it be, to chronicle two typical examples in our own land and time.

In the year 1875 a leader in American industrial enterprise created at the capital of a Southern State a university which bore his name. It was given into the hands of one of the religious sects most powerful in that region, and a Bishop of that sect became its President. To its chair of Geology was called Alexander Winchell, a scholar who had already won eminence as a teacher and writer in that field, a professor greatly beloved and respected in the two universities with which he had been connected, and a member of the sect which the institution of learning above referred to represented.

But his relations to this Southern institution were destined to be brief. That his lectures at the Vanderbilt University were learned, attractive, and stimulating even his enemies were forced to admit; but he was soon found to believe that there had been men earlier than the period assigned to Adam, and even that all the human race are not descended from Adam. His effort in this was to reconcile science and Scripture, and he was now treated by a Methodist Episcopal Bishop in Tennessee just as, two centuries before, La Peyrère had been treated for a similar effort by a Roman Catholic Vicar-General in Belgium. The publication of a series of articles on the subject, contributed by the professor to a Northern religious newspaper at its own request, brought matters to a climax, for, the articles having fallen under the notice of the leading Southwestern organ of the denomination controlling the Vanderbilt University, the result was a most bitter denunciation of Prof. Winchell and of his views. Shortly afterward the professor was told by Bishop McTyeire that "our people are of the opinion that such views are contrary to the plan of redemption," and was requested by the bishop to quietly resign his chair. To this the professor made the fitting reply: "If the board of trustees have the manliness to dismiss me for cause, and declare the cause, I prefer that they should do it; no power on earth could persuade me to decline."

"We do not propose," said the bishop, with quite gratuitous suggestiveness, "to treat you as the Inquisition treated Galileo."

"But what you propose is the same thing," rejoined Dr. Winchell. "It is ecclesiastical proscription for an opinion which must be settled by scientific evidence."

Twenty-four hours later Dr. Winchell was informed that his chair had been abolished, and its duties, with its salary, added to those of a colleague; the public were given to understand that

the reasons were purely economic; the banished scholar was heaped with official compliments, evidently in hope that he would keep silence.

Such was not Dr. Winchell's view. In a frank letter to the leading journal of the university town he stated the whole matter. The intolerance-hating press of the country, religious and secular, did not hold its peace. In vain the authorities of the university waited for the storm to blow over. It was evident, at last, that a defense must be made, and a local organ of the sect, which, under the editorship of a fellow-professor, had always treated Dr. Winchell's views with the luminous inaccuracy which usually characterizes a professor's ideas of a rival's teachings, assumed the task. In the articles which followed, the usual scientific hypotheses as to the creation were declared to be "absurd," "vague and unintelligible," "preposterous and gratuitous." This new champion stated that "the objections drawn from fossiliferous strata and the like are met by reference to the analogy of Adam and Eve, who presented the phenomena of adults when they were but a day old, and by the flood of Noah and other cataclysms, which, with the constant change of nature, are sufficient to account for the phenomena in question"!

Under inspiration of this sort, the Tennessee Conference of the religious body in control of the university had already in October, 1878, given utterance to its opinion of unsanctified science as follows: "This is an age in which scientific atheism, having divested itself of the habiliments that most adorn and dignify humanity, walks abroad in shameless denudation. The arrogant and impertinent claims of this science, 'falsely so called,' have been so boisterous and persistent, that the unthinking mass have been sadly deluded; but our university alone has had the courage to lay its young but vigorous hand upon the mane of untamed Speculation and say, 'We will have no more of this.'"

It is a consolation to know how the result, thus devoutly sought, has been achieved, for in the "ode" sung at the laying of the corner-stone of a new theological building of the same university, in May, 1880, we read:

> "Science and Revelation here
> In perfect harmony appear,
> Guiding young feet along the road
> Through grace and nature up to God.

It is also pleasing to know that while an institution calling itself a university thus violated the fundamental principles on which any institution worthy of the name must be based, another institution which has the glory of being the first in the entire North to begin something like a university organization—the State University of Michigan—recalled Dr. Winchell at once to

his professorship, and has honored itself by maintaining him in that position, where, unhampered, he has ever since been able to utter his views in the midst of the largest body of students on the American continent.

Disgraceful as this history was to the men who drove out Dr. Winchell, they but succeeded, as various similar bodies of men making similar efforts have done, in advancing their supposed victim to higher position and more commanding influence.*

A few years after this suppression of earnest Christian thought at an institution of learning in the western part of our Southern States, there appeared a similar attempt in sundry Southeastern States.

As far back as the year 1857 the Presbyterian Synod of Mississippi passed the following resolution:

"*Whereas*, We live in an age in which the most insidious attacks are made on revealed religion through the natural sciences, and as it behooves the Church at all times to have men capable of defending the faith once delivered to the saints;

"*Resolved*, That this presbytery recommend the endowment of a professorship of Natural Science as connected with revealed religion in one or more of our theological seminaries."

Pursuant to this resolution such a chair was established in the theological seminary at Columbia, S. C., and James Woodrow was appointed professor. Dr. Woodrow seems to have been admirably fitted for the position—a devoted Christian man, accepting the Presbyterian standards of faith in which he had been brought up and at the same time giving every effort to acquaint himself with the methods and conclusions of science. To great natural endowments he added constant labors to arrive at the truth in this field. Visiting Europe, he made the acquaintance of many of the foremost scientific investigators, became a student in university lecture-rooms and laboratories, an interested hearer in scientific conventions, and a correspondent of leading men of science at home and abroad. As a result he came to the conclusion that the hypothesis of evolution is the only one which explains various leading facts in natural science. This he taught, and he

* For Dr. Winchell's original statements, see Adamites and Pre-Adamites, Syracuse, N. Y., 1878. For the first important denunciation of his views, see the St. Louis Christian Advocate, May 22, 1878. For the conversation with Bishop McTyeire, see Dr. Winchell's own account in the Nashville American, June 16, 1878. For the curious reply from Dr. Winchell's colleague, see the Nashville Christian Advocate, July 12, 1878; and for the further development of the matter, see the Nashville American of July 19, 1878. For the further course of the attack in the denominational organ of Dr. Winchell's oppressors, see the Nashville Christian Advocate, April 26, 1879. For the oratorical declaration of the Tennessee Conference upon the matter, see the Nashville American, October 15, 1878; and for the "ode" regarding the "harmony of science and revelation" as supported at the university, see the Nashville American, May 2, 1880.

also taught that such a view is not incompatible with a true view of the sacred Scriptures.

In 1882 and 1883 the board of directors of the theological seminary, in fear that "skepticism in the world is using alleged discoveries in science to impugn the Word of God," requested Prof. Woodrow to state his views in regard to evolution. The professor complied with this request in a very powerful address, which was published and widely circulated, to such effect that the board of directors shortly afterward passed resolutions declaring the theory of evolution as defined by Prof. Woodrow not inconsistent with perfect soundness in the faith.

In the year 1884 alarm regarding Dr. Woodrow's teachings began to show itself in larger proportions, and a minority report was introduced into the Synod of South Carolina declaring that "the synod is called upon to decide not upon the question whether the said views of Dr. Woodrow contradict the Bible in its highest and absolute sense, but upon the question whether they contradict the interpretation of the Bible by the Presbyterian Church in the United States."

Perhaps a more self-condemnatory statement was never presented, for it clearly recognized, as a basis for intolerance, at least a possible difference between "the interpretation of the Bible by the Presbyterian Church" and the teachings of "the Bible in its highest and absolute sense."

This hostile movement became so strong that, in spite of the favorable action of the directors of the seminary, and against the efforts of a broad-minded minority in the representative bodies having ultimate charge of the institution, the delegates from the various synods raised a storm of orthodoxy and drove Dr. Woodrow from his post. Happily, he was at the same time professor in the University of South Carolina in the same city of Columbia, and from his chair in that institution he continued to teach natural science with the approval of the great majority of thinking men in that region; hence, the only effect of the attempt to crush him was, that his position was made higher, respect for him deeper, and his reputation wider.

In spite of attempts by the more orthodox to prevent students of the theological seminary attending his lectures at the university, they persisted in hearing him; indeed, the reputation of heresy seemed to enhance his influence.

It should be borne in mind that the professor thus treated had been one of the most respected and beloved university instructors in the South during more than a quarter of a century, and that he was turned out of his position with no opportunity for careful defense, and indeed without even the formality of a trial; well did an eminent but thoughtful divine of the Southern Presbyte-

ian Church declare that "the method of procedure to destroy volution by the majority in the Church is vicious and suicidal," nd that "logical dynamite has been used to put out a supposed re in the upper stories of our house, and all the family in the ouse at that." Wisely, too, did he refer to the majority as "sowig in the fields of the Church the thorns of its errors, and cumberig its path with the *débris* and ruin of its own folly."

To these recent cases may be added the expulsion of Prof. Toy om teaching under ecclesiastical control at Louisville, and his lection to a far more influential chair at Harvard University; ie driving out from the American College at Beyrout of the oung professors who accepted evolution as probable, and the rise f one of them at least, Mr. Nimr, to a far more commanding posion than that which he left—the control of three leading journals t Cairo; the driving out of Robertson Smith from his position at dinburgh, and his reception into the far more important and inuential professorship at the English University of Cambridge; nd multitudes of similar cases. From the days when Cotton Iather drove out Henry Dunster, the first President of Harvard ollege, for "falling into the briers of Antipedobaptism" until ow, the same spirit is shown in all such attempts. In each we ave generally on one side a body of the older theologians who, nce their youth, have learned nothing and forgotten nothing, ndry professors who do not wish to rewrite their lectures, and mass of unthinking ecclesiastical persons of little or no imporance save in making up a retrograde majority in an ecclesiastical ribunal; on the other side we have as generally the thinking, pen-minded, devoted men who have listened to the revelation of heir own time, as well as of times past, and who are evidently hinking the future thought of the world.

Here we have survivals of that same oppression of thought y theology which has cost the modern world so dear; the system hich forced great numbers of professors, under penalty of depriation, to teach that the sun and planets revolve about the earth; hat comets are fire-balls flung by an angry God at a wicked orld; that insanity is diabolic possession; that anatomical inestigation of the human frame is sin against the Holy Ghost; hat chemistry leads to sorcery; that taking interest for money is rbidden by Scripture; that Geology must conform to ancient Iebrew poetry. From the same source came in Austria the rule f the "Immaculate Oath," under which university professors, ng before the dogma of the Immaculate Conception was defined y the Church, were obliged to swear to their belief in that dogma efore they were permitted to teach even Arithmetic or Geomry: in England, the denunciation of inoculation against smallox; in Scotland, the protests against using chloroform in child-

birth as "vitiating the primal curse against woman"; in France, the use in clerical schools of a historical text-book from which Napoleon was left out; and, in America, the use of manuals in which the Inquisition is declared to be a purely civil tribunal, or the Puritans tolerant.

So, too, among multitudes of similar efforts, abroad we have during centuries the fettering of professors at English and Scotch universities by test oaths, subscriptions to articles and catechisms without number. In our own country we have had in a vast multitude of denominational colleges, as the first qualification for a professorship, not ability in the subject to be taught, but fidelity to the particular shibboleth of the denomination controlling the college or university.

Happily, in these days such attempts generally defeat themselves. The supposed victim is generally made a man of mark by persecution, and advanced to a higher and wider sphere of usefulness. As regards withstanding the march of scientific truth, any opposing Conference, Synod, Board of Commissioners, Board of Trustees, or Faculty, is but as a nest of field-mice in the path of a steam plow.

The harm done to religion in these attempts is far greater than that done to science; for thereby suspicions are widely spread, especially among open-minded young men, that the accepted Christian system demands a concealment of truth, with the persecution of honest investigators, and therefore must be false. Well was it said in substance by President McCosh, of Princeton, that no more sure way of making unbelievers in Christianity among young men could be devised than preaching that the doctrines arrived at by the great scientific thinkers of this period are opposed to religion.

Yet it is but justice here to say that more and more there is evolved out of this past history of oppression a better spirit which is making itself manifest with power in the leading religious bodies of the world. In the Church of Rome we have to-day such utterances as those of St. George Mivart, declaring that the Church must not attempt to interfere with science; that the Almighty in the Galileo case gave her a distinct warning that the priesthood of science must remain with the men of science. In the Anglican Church and its American daughter we have the acts and utterances of such men as Archbishop Tait, Dean Stanley, and many others, proving that the deepest religious thought is more and more tending to peace rather than warfare with science; and in the other churches, especially in America, while there is yet much to be desired, the welcome extended in many of them to Alexander Winchell, and the freedom given to views like his, augur well for a better state of things in the future.

From the science of Anthropology, when rightly viewed as a whole, has come the greatest aid to those who work to advance Religion rather than to promote any particular system of Theology; for Anthropology and its subsidiary sciences show more and more that man, since coming upon the earth, has risen, from the period when he had little, if any, ideas of a great power above him, through successive stages of fetichism, shamanism, and idolatry toward better forms of belief, making him more and more accessible to nobler forms of religion. The same sciences show, too, within the historic period the same tendency, and especially within the events covered by our sacred books, a progress from fetichism, of which so many evidences crop out in the early Jewish worship as shown in the Old Testament Scriptures, through polytheism, when Jehovah was but "a god above all gods," through the period when he was "a jealous God," capricious and cruel, until he is revealed in such inspired utterances as those of the nobler Psalms, the great passages in Isaiah, the sublime preaching of Micah, and, above all, through the ideal given to the world by Jesus of Nazareth.

Well indeed has an eminent divine of the Church of England in our own time called on Christians to rejoice over this evolution "between the God of Samuel, who ordered infants to be slaughtered, and the God of the Psalmist, whose tender mercies are over all his works; between the God of the Patriarchs, who was always repenting, and the God of the Apostles, who is the same yesterday, to-day, and forever, with whom there is no variableness nor shadow of turning; between the God of the Old Testament, who walked in the garden in the cool of the day, and the God of the New Testament, whom no man hath seen nor can see; between the God of Leviticus, who was so particular about the sacrificial furniture and utensils, and the God of the Acts, who dwelleth not in temples made with hands; between the God who hardened Pharaoh's heart, and the God who will have all men to be saved; between the God of Exodus, who is merciful only to those who love him, and the God of Christ—the heavenly Father—who is kind unto the unthankful and the evil."

However overwhelming, then, the facts may be which Anthropology and its kindred or subsidiary sciences may, in the interest of simple truth, establish against the theological doctrine of "the fall"; however completely they may fossilize various dogmas, catechisms, creeds, confessions, "plans of salvation" and "schemes of redemption," which have been evolved from the great minds of the theological period; science, so far from making inroads on religion, or even upon our Christian development of it, will strengthen all that is essential in it, giving new and nobler paths to man's highest aspirations. For the one great legitimate, scien-

tific conclusion of Anthropology is that more and more a better civilization of the world, despite all its survivals of savagery and barbarism, is developing men and women on whom the declarations of the nobler Psalms, of Isaiah, of Micah, the Sermon on the Mount, the first great commandment, and the second, which is like unto it, and St. James's definition of "pure religion and undefiled," can take stronger hold for the more effective and more rapid uplifting of our race.*

BARRIER BEACHES OF THE ATLANTIC COAST.

By FREDERICK J. H. MERRILL, Ph. D.

FROM Cape Cod to Cape Florida our coast is fringed with barrier beaches. They are the reefs of sand which protect the mainland shore from the storm-waves of the ocean. Isolated and uninhabited were most of these sea-born barriers for a long period in the history of our country, but the need of a breathing-place on the part of the thousands who inhabit our crowded cities has caused, within a few years, a great transformation. Railroad and turnpike bridges have been built, connecting many of them with the shore. Hotels and cottages, club-houses and bathing-houses, in short, buildings for every purpose which contributes to the pleasure and comfort of man have sprung up, as it were by magic, on the south shore of Long Island, on the coast

* For the resolution of the Presbyterian Synod of Mississippi in 1857, see Prof. Woodrow's speech before the Synod of South Carolina, October 27 and 28, 1884, p. 6. As to the action of the Board of Directors of the Theological Seminary of Columbia, see *ibid.* As to the minority report in the Synod of South Carolina, see *ibid.*, p. 24. For the pithy sentences regarding the conduct of the majority in the synods toward Dr. Woodrow, see the Rev. Mr. Flinn's article in the Southern Presbyterian Review for April, 1885, p. 272 and elsewhere. For the restrictions regarding the teaching of the Copernican theory and the true doctrine of comets in the German University, see various histories of astronomy, especially Mädler. For the immaculate oath (Immaculaten Eid) as enforced upon the Austrian professors, see Luftkandl, Die Josephinischen Ideen. For the effort of the Church in France, after the restoration of the Bourbons, to teach a history of that country from which the name of Napoleon should be left out, see Father Loriquet's famous Histoire de France à l'Usage de la Jeunesse, Lyon, 1820, vol. ii; see especially table of contents at the end. The book bears on its title-page the well-known initials of the Jesuit motto A. M. D. G. (Ad Majorem Dei Gloriam). For examples in England and Scotland, see various English histories, and especially Buckle's chapters on Scotland. For a longer collection of examples showing the suppression of anything like unfettered thought upon scientific subjects in our American colleges, see Inaugural Address at the Opening of Cornell University by the author of these chapters. For the citation regarding the evolution of better and nobler ideas of God, see Church and Creed: Sermons preached in the Chapel of the Foundling Hospital, London, by A. W. Momerie, M. A., LL. D., Professor of Logic and Metaphysics in King's College, London, London, 1890.

of New Jersey, Virginia, and the Carolinas, on the famed sea-islands of Georgia, and on the coast of eastern Florida.

Much alike are these peninsulas and islands wherever we view them along the coast. The chief variation is in the vegetation which clothes them. The beaches of Long Island are almost barren, but from New Jersey southward many are covered with dense forests which vary in their trees according to the latitude. At Sandy Hook, oaks, red cedars, hollies, maples, and sassafras-trees grow in wonderful luxuriance. On Seven-Mile Beach and Holly Beach the swamp magnolia abounds among the others. In the Carolinas the palmetto appears, often ragged in outline and blighted by the winter frosts. In northern Florida the palmettos are more numerous and show the influence of a warmer climate, while on the southern extremity of the zone of barrier beaches the cocoanut palm, planted by accident or design, rears its leafy crown in luxuriant verdure.

It is not the design of the writer to describe in detail the beaches of the Atlantic coast, but rather to consider their history and mode of growth. As it has been his fortune to spend much time on the sea-shore of New Jersey, he proposes to discuss the barrier beaches of that State as types of their genus.

They are sandy islands and peninsulas, from two to twenty miles in length and from half a mile to a mile in width, separated by inlets and usually divided from the mainland by an interval of several miles, in which are broad expanses of salt meadow, fringing and separating a series of channels, bays, and sounds.

The beaches which are now in their highest state of development are Sandy Hook, Seven-Mile Beach, and Holly Beach near Cape May. These typical examples of the sea-born barriers are much alike in structure, and consist of four principal divisions. The first division, or interior, is an undulating area covered with heavy timber, of which the size suggests its age. Immense hollies, oaks, pines, and red cedars abound, many of the first measuring two feet in diameter, and some of the latter attaining a circumference of four or five yards. The sassafras grows in remarkable luxuriance and immense grape-vines are everywhere to be seen, overhanging a dense undergrowth. In spring and summer the ground is covered with fragrant blossoms; columbines, violets, pinks, orchids, and a host of other flowers lend their bright colors to enhance the varied greens of the foliage. This is the beach primeval. Skirting it seaward is the second division, which bears smaller timber. Low cedars, hollies, and pines are here the chief forms of arboreal vegetation, and fewer flowering plants are seen. This zone is of later formation, and its trees are younger than those of the first. Adjoining it is the third division, which consists of a belt of undulating dunes a few hundred feet or yards

in width, and bearing the mossy Hudsonia or scrubby bushes of beach plum and wax-myrtle, or in some places, especially on the outer row of dunes, only supporting a meager growth of beach grass. Frequently, between two rows of dunes, an expanse of salt meadow occurs, or a sand flat bearing stunted forms of plant life. With this third division ends the domain of vegetation, succeeded by the sloping strand upon which the tide rises and falls. The sand-bar, exposed at low water at the extremity of the beach, is constantly increased in length and height by the action of the currents, and the process of beach formation is here continually in progress.

As the tide falls, the sand laid bare is rapidly dried by the wind and carried above high-water mark. Then, safe beyond the reach of the waves, the minute particles are borne still farther from the water, and striking against some piece of drift-wood, bush, or tuft of grass, quickly build a hillock, which grows larger and larger as more sand falls upon it, and a dune is formed many feet in height. The material of which these dunes are composed is never at rest, but flies hither and thither with the wind, and a hillock ten or fifteen feet high to-day may noiselessly be taken down to-morrow and rebuilt a hundred yards away. In time, as the beach grows seaward and the dunes increase in number, those of earlier formation, which are somewhat protected from the breeze, catch a few seeds, and tufts of grass begin to grow upon them. Still later, the mossy Hudsonia or some starveling wax-myrtle finds a little sustenance, and as years elapse the dunes become so thickly covered with vegetation that under the protection of the seaward hillocks they retain their form with comparatively little change.

Thus have the beaches grown. First a sand flat built by ocean waves and currents; then a series of low, shifting dunes; next sheltered hillocks, on which grasses and shrubs fasten their protecting roots; succeeding the latter a growth of small cedars and pines; and, finally, as centuries roll on, majestic forest trees raise their spreading tops and shelter a dense undergrowth.

These few words suffice to describe the beaches' growth, their physiology; but many pages might be written upon their history, the details of their development, their changes and their decay. Unfortunately, the records are but incomplete. From the memories of old men we can glean some facts in regard to the former condition and extent of certain beaches and concerning marked changes in them which have been notable events to men of quiet lives. In a few instances, surveys were made a century or two ago which can be compared with those of to-day. At present we can watch the changes which occur from year to year. As geological science advances we can speculate concerning the past as

the basis of present knowledge and observation. We have little accurate information, but, after all, we have much that is interesting.

The beach of Sandy Hook forms the northern extremity of the New Jersey sea-coast. Previous to 1778 it was connected with the base of the Navesink Highlands by a sandy isthmus, the mouths of the Navesink and Shrewsbury Rivers being open to the east; but from that date until about 1830, and from 1848 until 1889, it has been united with the mainland at Monmouth Beach by a narrow strip of sand.

According to records in the office of the Surveyor-General of East Jersey and in that of the United States Coast Survey, the point of Sandy Hook advanced northward about one mile between 1685 and 1885. The lighthouse was built about 1764 near the water's edge, and the ground on which it stands had then existed for only fifteen years as a portion of *terra firma*.

In 1844 the point was about two hundred and fifty yards north of its present limit. Since that date it has receded slowly toward the south, and toward the west has extended a quarter of a mile. We have no evidence concerning the date of formation of the old "Hook" which existed before 1685. It is now well marked by immense forest trees, which exceed in height and size of trunk any of their species known to the writer in the neighborhood of New York.

The rapid growth of Sandy Hook is due to a current which flows northward from the vicinity of Manasquan, carrying with it a great quantity of sand removed from the water front of Asbury Park, Long Branch, Seabright, and that vicinity, which is dropped along the border of the "Hook" and its extremity. The investigations of the United States Coast and Geodetic Survey have shown that the ebb and flow of the tides from and to New York Bay produce this current by drawing a stream of water through False Hook Channel, which lies between Sandy Hook and a submerged bar called False Hook half a mile to the east. The stream flows northward more than seven hours out of twelve, and from this fact property-owners in the neighborhood of Long Branch may appreciate what becomes of their real estate when it disappears during the storms. If there were any means of identifying the soil, it might all be found on the rapidly growing point of Sandy Hook.

About 1778 a channel was opened across the narrow isthmus which united Sandy Hook with the base of the Navesink Highlands, and a new passage being thus afforded for the tidal currents of the Navesink and Shrewsbury Rivers, the old Shrewsbury Inlet, which formed the common mouth of those two estuaries, was gradually closed by the northward extension of the sand-spit

which formed the southern limit, and in 1810 became impassable. The barrier thus formed existed until 1830 or 1831, when it was broken through and a second inlet was created. By a change in the tidal currents, due to the formation of this new inlet, the isthmus which formerly connected Sandy Hook with the Highlands of Navesink was again brought into existence and remained until 1835. An artificial channel was then cut through it, and this being gradually deepened and widened by the ebb and flow of the tides, has ever since remained open. The second Shrewsbury inlet closed in 1840 near Island Beach, having moved northward nearly three miles during its existence of nine or ten years. In 1837 or 1838 the third and last inlet opened near the present Bellevue Hotel, and afforded a better channel for navigation than the second inlet, which it followed in its northward course and survived by about eight years. From 1848 until September, 1889, no inlet has been opened; but this fact is due rather to the efforts of the railroad company to maintain its road-bed than to a diminution of the tendency of the waves and tidal currents to open a passage.

The facts and dates concerning the Shrewsbury Inlets have been obtained chiefly by inquiry from old fishermen and sailors who have spent their lives on or near the waters of the Navesink and Shrewsbury Rivers. Coming from a number of independent sources, they agree very closely, and those here given may be accepted as worthy of credence. The tendency of the inlets to work northward, periodically closing and reopening farther south, has been observed in all those between Point Pleasant and Sandy Hook, especially in those of Manasquan and Shark Rivers. Between Point Pleasant and Cape May, however, all the inlets are moving southward.

From Monmouth to the head of Barnegat Bay there is no beach similar to that of Sandy Hook. Instead of a sand-reef separated from the main land by a navigable channel, there is only the sloping strand adjoining, as at Long Branch, the foot of an upland bluff, or as at Spring Lake, Seagirt, and Point Pleasant, with its crest on a level with the surface of the upland. Between Bay Head and Cape May, however, there are twelve beaches, mostly well developed and preserved, and named respectively Squan, Island, Long, Island or Little, Brigantine, Absecon, Peck's, Ludlam's, Seven Mile, Five Mile or Holly, Two Mile, and Poverty. The majority of these, however, do not show the high degree of development exhibited by Seven-Mile and Five-Mile Beaches. Some appear to be only in the earlier stages of growth, while others have passed their prime and are now yielding to the attacks of wind and wave.

These agents have been hitherto considered only with reference

to their constructive effect on the beaches, and it now remains to consider their destructive action.

When the wind blows from the west it carries back to the sea much of the sand which the east wind had piled up in dunes, and, but for the fact that the latter wind prevails, the sand-hills would not long exist. By a surplus of constructive action, however, the beaches are all moving to the west. Year after year sand is removed from their eastern margin by the winter storms, and carried north or south according to the direction of the prevailing current. The winds from the ocean drive the dunes westward, and, with the possible exception of Sandy Hook, all the beaches are now underlaid by an old salt meadow, originally formed in sheltered waters on their west side. In this turf, when exposed during an unusually low tide, the footprints of cattle are seen in many places, made, it is claimed, when the salt meadow was a pasture and lay on the shoreward side of the beach. This westward recession has, in many cases, amounted to more than a mile within two centuries.

On many of the beaches south of Point Pleasant the westward progress of the dunes has been made over and through the native forest. As a result of this, gnarled cedars, dying and dead, are found among the dunes; and in many cases stumps may be seen in the sand within reach of the tide.

Near the northern end of Seven-Mile Beach, at the time of the writer's visit in 1885, an immense dune forty feet in height and half a mile in length had been for many years encroaching steadily upon the dense forest. The tree-tops here projected above the summit of the ridge like the heads of drowning men above the waves; while on the outer flank of the overwhelming mass of sand the gnarled, skeleton trunks of those which had perished in it stood bare and grim, showing with dreary grayness the fate of the earlier victims of which the ragged and wave-worn stumps alone remained. A more desolate scene the writer has never witnessed.

At Long Branch the wear of the coast has been very great. According to the United States Coast and Geodetic Survey, a strip of land varying from three hundred to five hundred feet in width was removed between Deal Beach and Monmouth during the twenty-seven years preceding 1868. In the vicinity of Seabright the amount of wear was a little less than two hundred feet during that period. Of late years the rate of recession has been diminished in the neighborhood of Long Branch by the means of artificial protection employed, but near Seabright the shore line is said to have receded at least two hundred feet during the past quarter of a century. At Cape May the wear of the shore has been continuous except where the land is protected by jetties or

a stone sea-wall, the rate of encroachment varying from ten to thirty feet a year.

Besides these alterations produced in the beaches by their westward progress, the variations in the positions of the inlets and the subsidence of the coast have caused many important changes. The history of the Shrewsbury Inlets has already been given; it remains to mention a few of those south of Point Pleasant.

Squan and Island Beaches, which now form a peninsula about twenty miles long, terminating at Barnegat Inlet, were separated from 1750 to 1812 by Cranberry Inlet, which was nearly opposite the mouth of Tom's River. Since 1812 near the site of this old inlet there have been others of brief duration, and one is said to have existed before 1755 opposite the mouth of the Metedeconk River, which separated Squan Beach from the mainland.

The old Barnegat Lighthouse is said to have stood nearly six hundred yards north of the present south shore of the inlet, at a point now occupied by the center of the channel. In 1855 the old tower was at the water's edge, so that the inlet has moved southward approximately twenty yards per year.

Absecon Inlet, which separates Brigantine Beach from Absecon Beach, has encroached upon the latter about four hundred yards in twenty years; and the ocean front of that portion of Absecon Beach which is occupied by Atlantic City extended in 1855 nearly half a mile farther east than it did in 1885. About 1875 jetties were built which arrested the action of the tidal currents, and, the wear of the shore being thus prevented, a considerable area was restored.

Submerged tree-stumps and other evidences of a subsidence of the coast may be found on the beaches and the salt meadows, but a detailed enumeration of them would be beyond the scope of the present article.

In Cape May County the depression has not been less than twenty feet, and has possibly been much greater. The evidence of some old buildings on the shore of Delaware Bay suggests a subsidence of about four feet during the last two centuries.

It is doubtful whether depression *alone* has caused the wear of the coast. A comparison of the present outline of Holly Beach with that determined by a survey in 1772 shows an accretion on the south and east, since the latter date, more than three and a half miles long and averaging three eighths of a mile in width, and on many other beaches a similar growth has taken place. During the past five years the ocean has rapidly encroached upon these beaches, while the subsidence of the coast, so far as we know, has been uniform throughout the past two centuries. It would appear, therefore, that the growth and decay of the beaches

are more dependent upon the action of the ocean currents and winds than upon other agencies. Unquestionably the depression of the coast renders the beaches more subject to overflow and erosion by the waves and currents; but the evidence at many points shows that the latter are capable of forming large areas of beach where the conditions of their existence and action favor construction rather than destruction. While these currents act as at present, the cost of preventing the ravages of the sea, by the methods commonly in use, would probably be much greater than the value of the land protected, for the fine sand is so unstable when wet that bulkheads and breakwaters are quite ephemeral.

After an extended examination of the various systems of shore defense in use between Sandy Hook and Cape May, it appears to the writer that the only effectual means of protection is the construction of jetties extending far enough from the shore to intercept the currents which carry away the sand loosened by the waves. Such jetties have added a large area to the territory of Atlantic City, and have protected the shore at Cape May; no doubt they would be effective everywhere if properly constructed.

The experience of the past ten years on the New Jersey coast shows conclusively that the ocean front is not fit for building purposes, for it is impossible to protect a house near the water's edge from injury or destruction in the heaviest storms. The height and force of the waves in such a tempest as that of September 10 and 11, 1889, render them irresistible to any body or structure which nature or art has yet produced, and anything within their reach must suffer. The immediate water-front is only available for parks; and, if devoted to this use, when protected from the erosive action of the currents by suitable jetties, would remain a neutral ground which, in fair weather, would afford numberless attractions to the occupants of dwellings placed far enough from the strand to be out of reach of the storm-waves.

Property-owners along the ocean front of the beaches have generally made the mistake of supposing that the domain of the Atlantic was bounded by the high-water mark of the spring tides. Any one who should build a dwelling on the strand below ordinary high-water mark would be considered lacking in common sense, yet it is scarcely less foolish to build within reach of the storm-waves. It is, of course, true that many cottages are now much nearer the water's edge than they were a few years ago. This is due to the wear of the shore by currents already described as flowing parallel to it and removing the sand which the waves have loosened. If the action of these currents should be stopped —and there is good evidence to show that a system of jetties would intercept them and cause them to drop their stolen load of

sand—the wear of the shore would be arreste
croachments of the ocean would cease.

With regard to the inundation of Atlant
the great September storm of 1869 it shou
catastrophe ought not to be considered very
greater portion of the city is less than ten f
and the highest point recorded by the New
is only thirteen feet above that level. As
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lie between the beach and the mainland ar
landlocked and the inlets are relatively narro
soon raised to a height of two or three feet
and this is sufficient to cover most of the rai
sure, no such inundation as the recent one ha
lantic City became a place of importance, no
on the coast remember such a storm in for
evident that, while the beaches were uninhab
the one in question would attract less atte
cause little if any loss of property.

The genesis of the beaches is still a matte
it may be safely affirmed that they originated
under water by wave and current action. I
brought above water, so that the wind could
power, is uncertain. A plausible hypothesi
ocean was breaking on the mainland sho
Quaternary terraces, which may be seen th
made under water, and that the continental el
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feet above tide, brought these sand-bars abo
zon of Æolian action. Once above the sea
maintain their existence. A continued ele
would add to their seaward extent and a dep
a westward recession until they were broug
with the mainland shore. In New Jersey
may be observed between Long Branch and
also at Cape May.

So far as it is known to the writer, the
beach can be entirely destroyed is by an inlet
In this case the beach obliterated is replaced
an adjacent beach.

Of the beaches south of New Jersey not en
writer to permit of a detailed biographical ske
structure show that they have been subject to
agencies and vicissitudes as those already des

to the Georgia sea-islands of *ante-bellum* fame, may be mentioned as familiar examples the barriers which in Virginia and North Carolina separate Albemarle and Pamlico Sounds from the ocean; in Florida, Amelia Island on which is built the city of Fernandina; Anastasia Island, in front of St. Augustine; and the beaches which separate Halifax and Indian Rivers from the Atlantic. The last-named rivers are the lagoons which separate the barriers from the mainland shore. Lake Worth is one of these lagoons, of which the inlet has been closed.

To what extent the Florida Keys may be included in the category of barrier beaches must be decided by future investigation. Key West is evidently a wave-built sand-bar composed of fragments of coral, molluscan shells, and foraminifera, and it seems likely that Cayo Largo and others of that type may be of similar origin. The coquina deposits of the vicinity of St. Augustine are also wave-formed.

The hypothesis of Prof. Louis Agassiz, that the Florida Keys are all of organic origin—i. e., that they were formed by the growth of coral reefs—may be true so far as the determination of their location and direction. A submerged reef of coral may have formed a nucleus on which the waves and currents deposited a load of calcareous sand, but the superficial portion is evidently similar in origin to that of the beaches farther north.

Barrier beaches are found on all the sea-coasts of the world where opportunity for their growth has been afforded, and those of New Jersey may be regarded as types of these formations in all their essential features.

ANCIENT DWELLINGS OF THE RIO VERDE VALLEY.

By EDGAR A. MEARNS,
ASSISTANT SURGEON, U. S. A.

AS an officer of the medical department of the United States Army, the writer was assigned to the military department of Arizona in 1884, and took station at Fort Verde, in the central part of that territory, in March. Strange were the sensations that we experienced on the morning succeeding our arrival, as we looked for the first time upon the broad valley of the Rio Verde, hemmed in by rugged mountains on the west, and terraced limestone cliffs with intervening *mesas* on the east. To the northward Beaver Creek poured its turbid flood into the Verde, whose banks were filled to overflowing by the waters sent down by the melting snow upon the distant Mogollon Mountains. Eighty miles to the north, beyond the ruddy cliffs of the "Red Rock Country," San Francisco Peak, the highest point and most prominent landmark in the territory, gleamed in snowy white-

ness. Indeed, it retained its snow-cap far into the hot sumn months. The general course of the river at this point is a lit east of south. The eye vainly followed its winding course miles in either direction in quest of village or solitary dwelli Not a human habitation could be seen. The handful of soldi mounting guard upon the parade, to the music of trumpet, fife, a drum, but emphasized the solitude of the place. Trees mark the sinuous course of the stream, but the rest of the valley w bare of vegetation save patches of mesquite-bushes in the alluv river-bottom, the ever-present cactus, aloe, and yucca, and a l growth of intermingled weeds and grasses, whose blended hu imparted to the valley a yellowish color. Dwarfed cedars a piñons barely existed upon the arid slopes of the Black Hi range, bounding the valley upon the west, and tall pines crown their level summits.

I said there were no human habitations in sight; but clos scrutiny revealed stone edifices, erected by the hand of man, occ pying commanding points upon the opposite side of the valle huge piles of masonry, whose ruined walls still stand to a consi erable height. Below these, emerging upon narrow ledges, in th face of the nearest cliffs, were lines of black holes, which I wa told were entrances to the cave-dwellings of an extinct race men. From the hospital piazza a view was obtained of a sti more wonderful structure. In the vertical side of the cañon through which Beaver Creek flows, a large building four or fiv stories high had been built by this people, whose only history i written in monumental ruins.

Before our departure from Fort Verde in 1888 three railroad had penetrated toward the heart of the wilderness by which w were surrounded. Settlers were thronging in to engage in lum bering, mining, or stock-grazing in the mountainous portions, o to cultivate the soil of the irrigable valleys. Already the valle of the Verde begins to assume somewhat of the appearance tha it presented centuries ago, when irrigated and cultivated by th populous cliff-dwellers. Again the Indian corn rustles in th broad fields in autumn, and golden pumpkins and squashes clus ter beneath the stalks. Childish voices are borne on the breeze a new cycle begins.

Curiosity concerning the people whose stone buildings chal lenge attention from most of the prominent points along the Verd River and its tributary streams led me to pay some attention t the study of archæology, and to form a collection of such relics a might shed light upon the history and habits of the builders.*

* This collection, comprising several thousand specimens, has been donated to the American Museum of Natural History, New York. The human skeletons and crania will be sent to the Army Medical Museum at Washington.

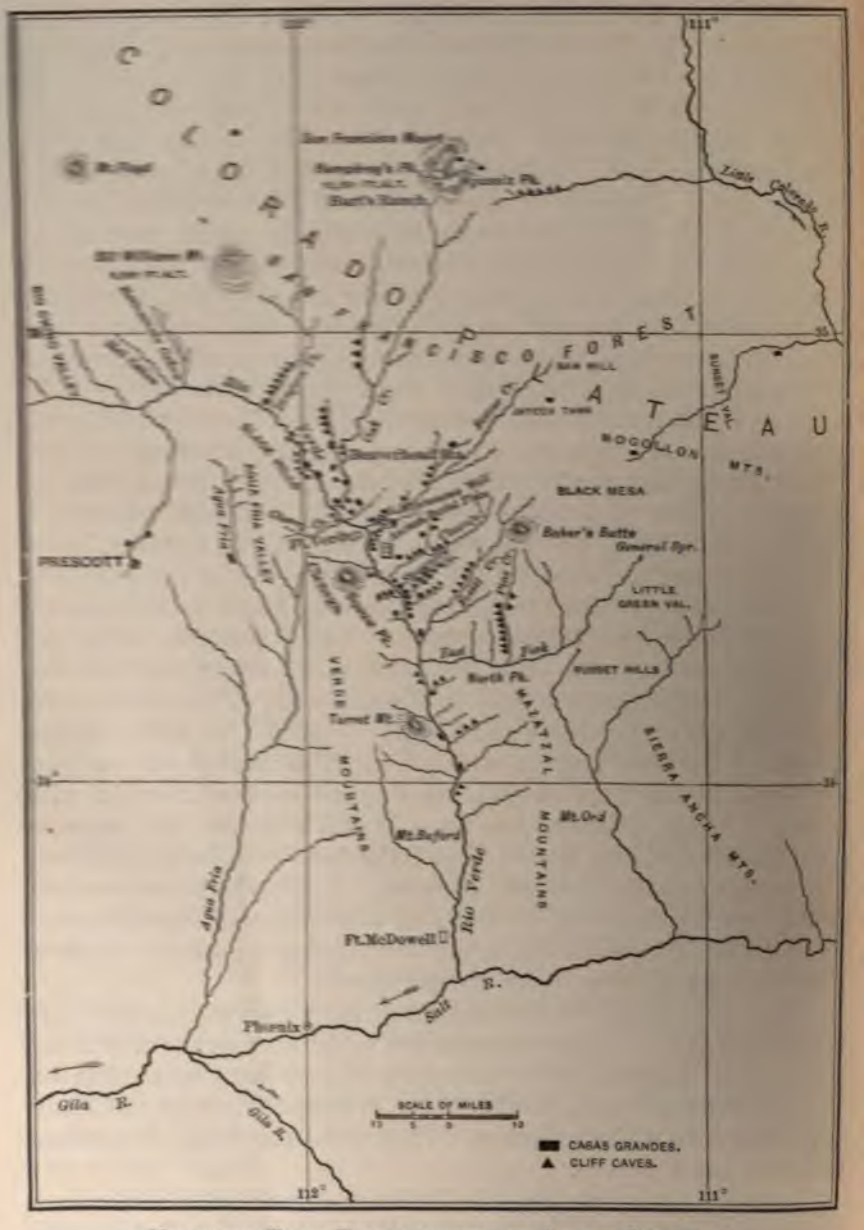
On turning to the fourth volume of Hubert H. Bancroft's Native Races of the Pacific States, which is devoted to the study of antiquities, I was surprised to find that the extensive ruins of the Verde were at that time (1875) undescribed and unknown, save through vague accounts received from Mr. Leroux and other guides and trappers. On page 636 we read: "These ruins are not very far from Prescott in the north and Fort McDowell in the south; and I regret not having been able to obtain from officers in the Arizona service the information which they must have acquired respecting those remains, if they actually exist, during the past ten or fifteen years." Some of these ruins have since been examined by archæologists accompanying Government surveying parties, and models of several of them are to be seen in eastern museums; but no exhaustive account of them has ever been written, nor have any been more than superficially explored.

The writer has availed himself of the opportunity afforded by numerous tours of field-service and authorized hunting expeditions, amounting in the aggregate to several thousand miles of travel, to examine most of the principal ruins in the territory, from the famous Casa Grande of the Gila itself to the smaller *casas* and caves on the head-waters of its tributaries. Although highly diverse in form, style, material, and location, it is evident that these buildings belonged to a single race. This is shown by the similarity of products and identity of habits, as well as by the relation of the dwellings to each other. The implements and pottery found in the rude caves of the Upper Verde are identical with those which Mr. Cushing has recently obtained from the immense *casas grandes* of Salt River. In all, the food substances and mode of agriculture are essentially the same. Again, the proudest *casas grandes* are built on the summits of cliffs whose sides are honeycombed with cave-dwellings, thus combining in a single community the most diverse styles of habitations.

Only the aboriginal monuments of the Verde region will here receive attention. They are uniform with those of the rest of the Gila Basin. In fact, little violence would be done by uniting all of our southwestern ruins with those of the northern tier of Mexican States into a single group. They were the work of substantially the same people.

The accompanying map indicates the location of only such remains as are personally known to the writer. Detailed descriptions of all of them would prove tedious to the reader and exceed our present limits.

The walled buildings are of two kinds—those occupying natural hollows or cavities in the faces of cliffs, and those built in exposed situations. The former, whose walls are protected by sheltering cliffs, are sometimes found in almost as perfect a state of preserva-



MAP OF THE VERDE VALLEY, SHOWING ITS ANCIENT DWELLINGS.

tion as when deserted by the builders, unless the torch has been applied. The latter, or Pueblo style of architecture, usually occupying high points and commanding a wide extent of country, are in a ruined state, although walls are commonly standing to the height of one or more stories, with some of the timbers intact.

Another and very common form of dwellings is the caves, which are excavated in the cliffs by means of stone picks or other implements. They are found in all suitable localities that are contiguous to water and good agricultural land, but are most numerous in the vicinity of large *casas grandes*. Most of them are in limestone cliffs, as the substratum of sandstone is not as commonly exposed in the cañons and cliffs, but many cavate dwellings are in sandstone.

The additional remains observed by me are mounds in the vicinity of ancient dwellings, extensive walls of stone and mortar, large quantities of stone implements and fragments of broken pottery, *acequias* or irrigating ditches, ancient burial grounds, and hieroglyphic inscriptions on stones and cliffs—the last two to be doubtfully referred to the cliff-dwellers.

FIG. 1.—CASA GRANDE IN RIGHT BLUFF OF A CAÑON ENTERING THE VERDE RIVER FROM THE EAST, ABOUT TWELVE MILES SOUTHEAST OF FORT VERDE.

Of the cliff-houses, as contradistinguished from those of Pueblo pattern, many excellent examples are found in the Verde region. One, into which I was probably the first white man to set foot, is built in the right wall of a deep cañon, between Hackberry Flat and the Rio Verde. It was found when searching for a still larger

FIG. 2.—" MONTEZUMA'S CASTLE.

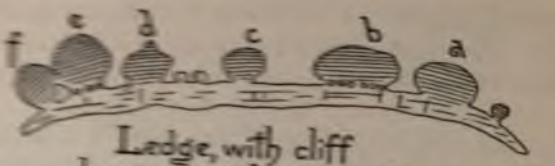
and more nearly perfect building near the same locality, which an old settler had found many years ago. There are many others on Beaver Creek, and in the "box cañons" of the Upper and Lower Verde.

The building known as "Montezuma's Castle," on the right bank of Beaver Creek, in sight of and three miles from Fort Verde, is (perhaps excepting a building near Salt River) the finest that I have seen, and typical of this class of structures. This *casa*, doubtless a fortress, is fitted into a natural depression, high up in a vertical limestone cliff, the base of which is distant three hundred and forty-eight feet from the edge of the stream and about forty feet above it. The *casa* is accessible only by means of ladders, its lowest foundations being forty-two feet above the bottom of the cliff. The post quartermaster of Fort Verde has provided four substantial wooden ones, which make the ascent easy from one narrow ledge to the next. After ascending three ladders a ledge is reached upon which six cave-rooms open (Fig. 3).

On a ledge eight feet below this one, and eighty feet to the northeast, are two cave-dwellings, neatly walled up in front, with a well-made window in each for entrance. There are many other cave-dwellings in the cliff, at either side of the *casa*, long lines of them extending toward the southwest. One or two isolated chambers, walled in front and windowed, may be seen far up the side of the cliff, where they are altogether inaccessible. These, together, constituted the settlement.

Ascending the fourth ladder (Fig. 6, *z*), the *casa* is reached. The foundation rests upon cedar timbers laid longitudinally upon flat stones on the ledge. The projecting ends of these timbers show plainly the marks of stone axes used in cutting them. The front wall (Fig. 4, *a b*) is a little over two feet wide at the bottom and thirteen inches wide at the top. It leans slightly in toward the cliff. One part of this wall (Fig. 5) rests on what appears to be a very precarious footing, although it has stood for centuries. The timbers are so placed that in the middle they project beyond the edge of the ledge.

The *casa* is entered at a projecting angle (Fig. 6, *c*), through a window of sub-Gothic form (Fig. 7), measuring three feet and three inches in height by two feet and four inches in width at the bottom. This small apartment (Fig. 6, *a*) is smoothly plastered within, and blackened by fire. The plastering bears finger-marks and impressions of the thumb and hand, showing that it was laid on and smoothed by the hands. The roof is formed by willows laid horizontally across eleven rafters of ash and black alder; upon this a thick layer of reeds is placed transversely, and the whole plastered on top with mortar, forming a floor to the chamber above it. The rafters are peeled, except one or two that

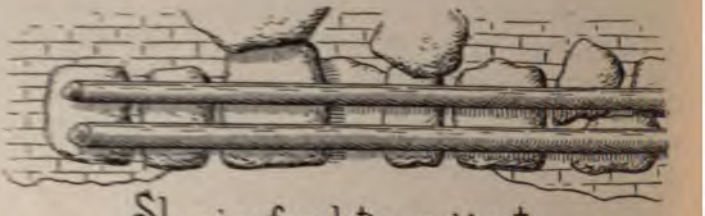


Ledge, with cliff chambers, below the Casa.

FIG. 2. 10 feet

Section of wall.

FIG. 4. 10 feet



Showing foundation support.

FIG. 5.

FIG. 7.
1 foot

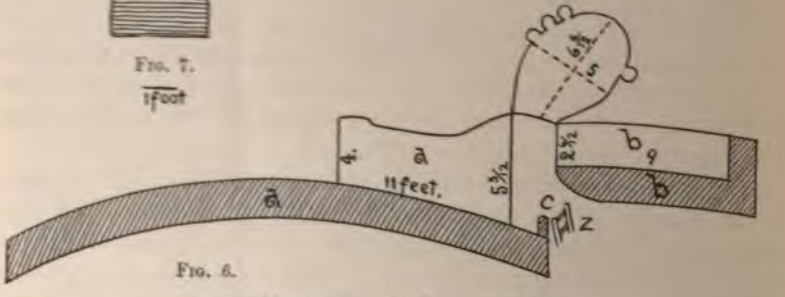


FIG. 6.

Plan of 1st floor of Casa.

10 feet.

were evidently taken dry. They average about fifteen inches in circumference, and were set into the walls at the time the latter were built. They were burned off flush with the wall outside.

Some of them show hatchet-marks, where branches were lopped off. From this room the only means of exit, except the window by which it was entered, is a small hole in the ceiling, just within the entrance (Fig. 8, *x*), measuring thirteen by eighteen inches, and bordered by flat stones laid upon the reed layer of the roof. These stones are smoothly polished by the hands of the dwellers in passing back and forth, as this was apparently the only means of entering the seventeen apartments above it. The traveler in this region is quite certain of being entertained by exaggerated stories about gigantic human skeletons having been discovered in the ruined *casas grandes;* but if he be a good-sized man, and possessed of the usual amount of adipose tissue appertaining to the age of threescore years, he will become skeptical thereof when he comes to squeeze himself through the narrow portals of the ancient halls of Montezuma's Castle.

Except a store-room, another small room (Fig. 6, *b*), separate from the one just described, is all that remains on the first floor. It can only be entered through a small scuttle in the floor of the room over it (Fig. 8, *t*).

The first and second stories occupy an outer ledge, lower than the rest of the *casa*. The great outer wall of the upper stories (Fig. 8, *c*) is founded upon a ledge in the rear of the second floor, forming its back wall.

The second story is much more spacious than the first. The roof of the latter brings the building to the level of another ledge, which, extending laterally in each direction, serves as a floor for additional rooms. This story is composed of a tier of four rooms, bounded behind by the most massive wall of masonry in the whole *casa*, which, as previously stated, rests on a ledge even with the floor of the second story. This arrangement, besides giving more room to the stories above, secured the greatest amount of stability to this wall, which is the most important in the structure. It is twenty-eight feet in height, rising to the fifth story, around the front of which it forms a battlement four and a half feet high. It leans slightly toward the cliff, and is strongly curved inward, though not symmetrically. The chord of the arc described by the top of the wall measures forty-three feet, and the greatest distance from chord to circumference eight feet. As the wall is built against the cliff, there is no way of ascertaining its thickness at the bottom. It is fourteen inches wide on top.

The third floor (Fig. 9) comprises the most extensive tier of rooms in the structure, extending across the entire alcove in the cliff in which the *casa* is built.

The balcony above rooms C and D of the second story, as stated, had a battlement around it, which is still intact where supported by the wall of room G. A portion of the flooring has

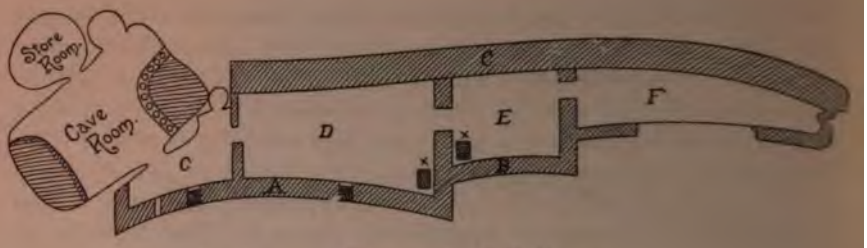


FIG. 8. Plan of 2nd Floor.

10 feet.

FIG. 9. Plan of 3d Floor

10 feet

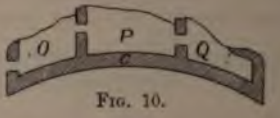


FIG. 10.

Plan of 4th Floor

10 feet

10 feet.

FIG. 11. Plan of 5th Floor.

broken down into room D of the second story. *Metates* and grinding-stones were of frequent use in its construction; this and other appearances lead us to the conclusion that this remarkable structure was not built at one time, but grew up gradually from successive building. The caves in the cliff were probably first inhabited and the *casas* subsequently erected.

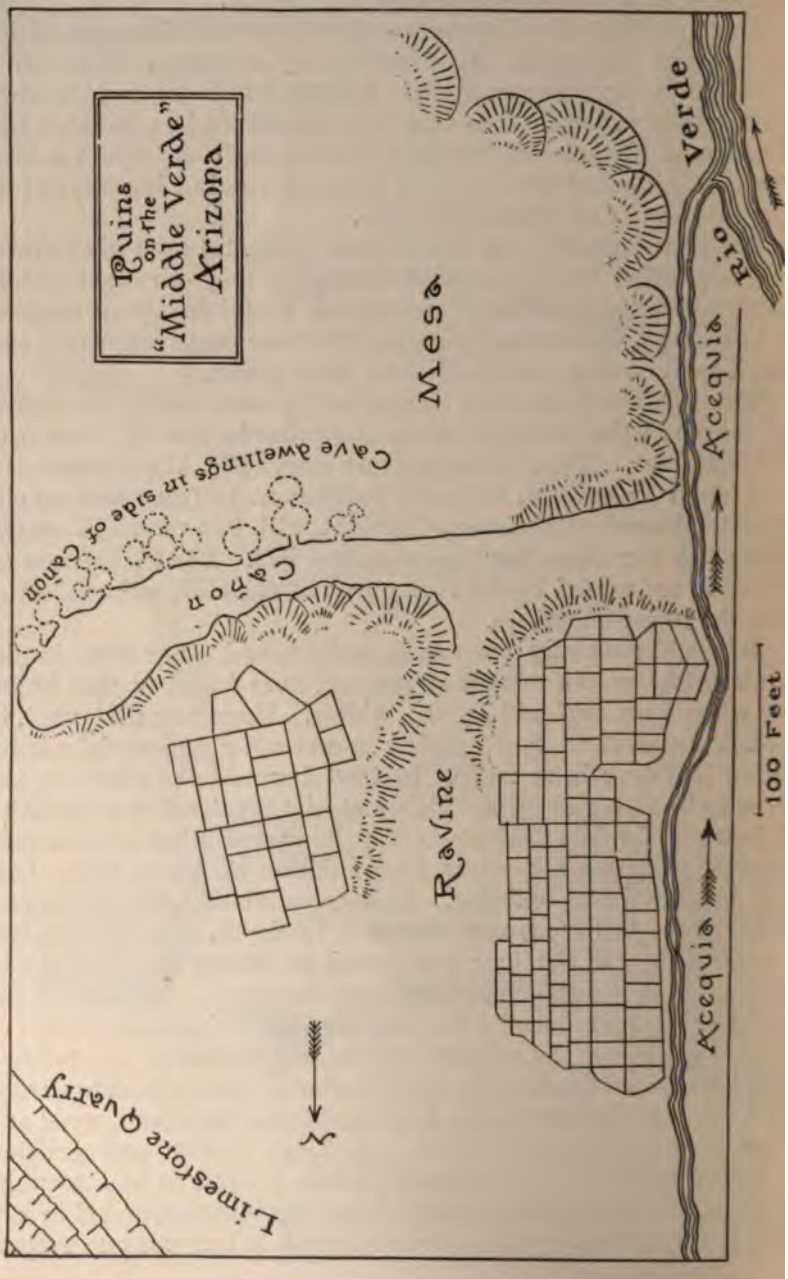
When taking the dimensions of room G on this floor a singular incident occurred. Mr. Daniels, my assistant, discovered a stone axe lying between the two timbers which formed the lintel of the window, the latter having been splintered by a bullet, which also struck the axe and loosened it in its position. Thus a careless shot, aimed at the building by some passing hunter, put us in possession of an interesting relic.

The apartments of the fourth floor (Fig. 10) are rather neater in construction than the rooms below, but they are otherwise so nearly alike that a detailed description would involve a needless and tiresome repetition of details. The door-ways are neatly executed, each having four good-sized lintel-pieces.

The fifth story can only be reached by climbing up through a small hole in the ceiling of room O, similar to that in room A of the first floor. This, the uppermost story (Fig. 11), consists of a long porch or gallery, having a battlement in front and an elevated backward extension on the right, with two rooms (R and S) filling the corresponding space on the left. The two rooms on this floor are roofed by the rocky arch of the cliff, and are loftier than the lower chambers.

It is said that only a few axes, *metates*, and other stone implements, with broken vessels of pottery, were found in this building when first explored by the whites. Upon my first visit, in 1884, it was evident that nothing more than a superficial examination had ever been made. In 1886 I caused the *débris* on the floors to be shoveled over. This material consisted of a quantity of dust and broken fragments of pottery and stone implements, together with an enormous accumulation of guano from bats that inhabited the building. This accumulation, in the largest room of the top floor, was four feet in depth. As no one had ever disturbed it, the floor was found in exactly the same condition in which it was left by the latest occupants. In front of the entrance the remains of a fire was found, and a goodly bundle of fagots lay against the wall at a convenient distance. An earthen vessel contained food, and a small basket of mesquite-seeds stood hard by. On further search, a large spoon of sycamore wood and some gourd cups were found. A large *metate* and grinder, weighing upward of a hundred pounds, proved to be a troublesome acquisition to our collection; but the labor expended in getting it safely down to the ground served to increase our respect

for those who carried it up. Shells and shell ornaments were secured, as well as paints of various colors. Some oven-shaped cupboards were built along the wall, containing remains of mescal, Spanish bayonet, nuts of the piñon-pine, and other food substances; and corn-cobs were found in abundance.



In other parts of the building several bone implements, including a corn-shucker and a handsomely wrought marlin-spike, fashioned from the leg-bone of deer, were obtained. Scalps or head-dresses were also unearthed. Indeed, the materials here found formed quite an extensive collection, including numerous food articles, bones of various animals, pieces of cloth, matting and basket-work, ropes and cords of cotton and yucca, sticks for fire-making, knitting or weaving, and many other uses.

None of the ancient buildings of this region exceed this one in picturesque grandeur, although many are more extensive. Its very location excites admiration and inspires respect for those who built it, whatever may have been the motive which prompted to the selection of such a site; nor is it lacking in architectural beauty. Its existence proves its great strength.

Of the ruined pueblos, an extensive group of buildings on the left bank of the Verde River, six miles northwest of Fort Verde, Arizona, may be fairly considered a representative example. This pueblo consisted of two terraced buildings surmounting a limestone cliff. The larger one, in which I have made some exploration, faces the Verde, the other fronting on a side cañon to the south; the walls of the latter, as well as the face of the cliff, contain numerous cave-dwellings, in which sundry articles of pottery and basket-work, as well as stone tools, were exhumed. The accompanying plan (Fig. 12) exhibits the relations of these structures. This ruin, which does not differ materially from many others in the Verde region, is quite similar to the inhabited villages of the Moquis of Eastern Arizona and the modern pueblos of New Mexico. As it was conveniently accessible from the fort, I made it the subject of some research, and caused considerable excavations to be made in parts of the larger building, and also in the caves of the adjacent cañon.

The larger edifice had been three stories in height in front, where it rested upon the level rock, thence terraced down the slope of a ravine behind it, the lower tiers of rooms having apparently been but a single story in height. Previous to my first visit the front of the building had been thrown down over the cliff by the white settlers to supply material for repairing an old *acequia*, which has since served the whites, as it did the cliff-dwellers of old, with water for irrigating purposes. Several of the ranchmen in the vicinity called my attention to articles made of pottery, and a varied assortment of interesting relics, which they had secured when tearing down the ruin, in which they claimed to have discovered dozens of human skeletons, one of gigantic stature (the usual story), and a quantity of burial urns and other vessels of pottery and stone. These accounts were in some measure substantiated by the abundance of broken pottery,

rough mortars, *metates*, and stone implemer
walls of the new *acequia*. The writer, whos
ery had been whetted by his surprising suc
in the high tier of cave-dwellings in the fr
Creek, eleven miles to the southeast, immed
examination of this majestic pile of ruir
mound two hundred and eighty feet in lengt
in width, having an average depth of seve
walls are now standing to that height, th
filled with the *débris* of the fallen upper s
had been destroyed by fire, three layers of

FIG. 13.—METATE AND GRINDING-STONE FROM CASA GRANDE
MILES NORTH OF FORT VERDE.

bish corresponding to the roof and ceilings,
constructed of wood, reeds, and grass. Near
materials had been destroyed, while many
even some of stone, had been cracked and
and the greater part of the pottery, of which
unearthed, had been broken by the fallen wa

The labor of removing the *débris* fro
rather slow and difficult. As most of the po

FIG. 14.—SHELL ORNAMENTS, ARROW-POINTS, AND STONE FROM A WAR-CLUB, FROM VARIOUS PARTS OF THE VERDE VALLEY.

were found upon the ground floor, the excitement of the quest increased proportionately as the bottom was approached. The standing walls were found to be from one and a half to three

and a half feet in thickness, sometimes pl
The upper walls were doubtless of adobe, a
tains a large quantity of that material. Th
quarry in the rear of the buildings.

The rooms were spacious and the floor
Beneath them were found vaults, plastere

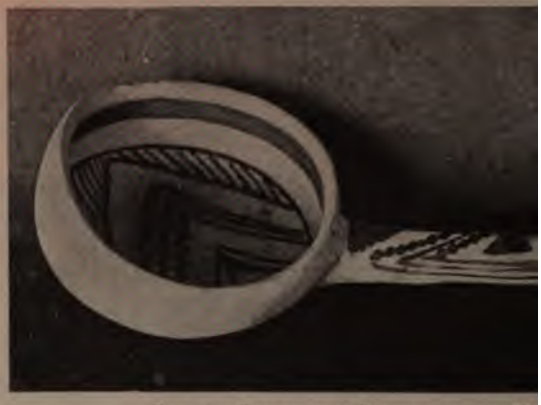


FIG. 15.—LADLE FROM RUINS NEAR THE VE

human skeletons. In one room, ranged alo
the substantial partition walls, were tombs
the sepulture of infants and children. The
with large, flat stones, some of which were
of them an *olla* was found, with the skeleto

FIG. 16.—ANCIENT POTTERY FROM THE VERI

bodies apparently had not been incased in
the case with those found in the burial cav
well as some of the adult skeletons exhume
this building.

This *casa* proved quite productive in mi
rial, but most of the more perishable article

Of stone implements, the *metates*, used for grinding maize, form an exceedingly interesting set of specimens, exhibiting considerable variation in size and form. The greater number were of the hard, porous, gray scoria known as *malpais*, a material well adapted for grinding. Others were hewn out of sandstone, varying in color from red to creamy white. The manner in which they are fashioned with no better tool than another stone speaks in eloquent praise of the skill and indefatigable patience of these aboriginal workmen. A series of these primitive stone mills may be seen in the writer's collection at the American Museum. Grooved stone axes and hatchets were numerous, and likewise exhibit an unusually wide range of variation in size, shape, material, and workmanship. Several of them are, in form and finish, scarcely inferior to the modern articles. Some of the picks and hammers were also models of the handicraft of the stone age. Not the least interesting were stone wedges (doubtless intended for splitting timbers) and agricultural tools. There was also a large assortment of stone knives, resembling in shape the chopping-knife of modern housewives. Heavy malls, pipes of lava, whetstones, polishing-stones, and other implements whose use is not apparent, were obtained, besides mortars and pestles, stone vessels, and plates or platters of volcanic rock. Besides such articles of domestic use, there were the implements of warfare and the chase, including rounded stone hammers, mostly of sandstone and scoria, grooved for attachment to a handle by means of a hide thong; also grooved stones used in arrow-making, spear-heads and arrow-points of obsidian or agate, and flints from the war-club (*maquahuitl*).

Pigments—red, blue, gray, and black—were found; also a heavy, black powder, and the usual chipped pieces of obsidian (volcanic glass) and agate, together with ornamental pebbles, etc. Nor were ornaments lacking, such as amulets of shells and rings of bone and shell. Several heavy pieces of obsidian, which were probably transported from New Mexico, were doubtless kept in stock for the manufacture of knives and weapons. A heavy block of red catlinite, or "pipe-stone," of which small fetiches found in several localities were made, extends the commerce of this people to the region of the Upper Missouri, where the only known quarries of this material exist; and sea-shells, doubtless from the Pacific, are of equal interest, as showing the extent of traffic to the westward.

In several rooms large earthenware vessels were uncovered, which, although broken, were still held in position by the pressure of their contents and the earth surrounding them; fine rootlets also penetrated the cracks and formed a meshwork serving to hold them together. The largest were of coarse material and

had a capacity of about thirty gallons. Some of the smaller pieces were unbroken, and, although unglazed, were smoothly finished and decorated in colored patterns with rare taste. There were ladles or dippers, shallow saucers, graceful *ollas*, and vases displaying much artistic feeling in their conception and execution. One room appeared to have served as a store-room for earthenware utensils, some of which were found in nests, contained one within another, the smaller specimen measuring but one and one fourth inches in diameter. A few perforated discs of pottery, resembling wooden ones from cliff and cave dwellings, were noted.

Numerous tools of bone, chiefly such as were employed in the manufacture of ropes, neatly carved from the bones of deer or antelope, were among the relics found. Various food substances were examined, including bones, teeth, or horns (usually charred by fire) of elk, mule-deer, antelope, beaver, spermophile, pouched gopher, wood-rat, muskrat, mice, cotton-tail and jack-rabbit, turkey, serpent, turtle, and fish. A sandal of yucca, differing in design from that taken from the wall of Montezuma's Castle, and several pieces of human scalps, complete the list of relics from this *casa*.

There are many ruins of the class just described in the Verde region, as indicated on the accompanying map. Among them are several conspicuously perched on the summits of high, isolated, flat-topped buttes on the Rio Verde and on Oak, Beaver, and other tributary creeks; others are built on the precipitous edges of table-lands bordering cañons in which streams flow; while some occupy lower positions in the valleys. It would appear, from the location of some of these *casas grandes*, that the water supply has diminished or otherwise greatly altered since they were occupied, as there is now no water to be found within several miles of them. Cisterns were doubtless utilized, but must have proved inadequate to supply the needs of so large a population.

These pueblos frequently inclosed an open square or court. There is such a one on Oak Creek, built on a bluff butte, level on the top, which is one hundred and twenty-five feet above the surrounding *mesa*. The building is subrectangular in shape, conforming to that of the summit of the butte, the sides of which are precipitous. Other villages, perhaps less prosperous on account of their inferior advantages for agriculture, are to be seen in many localities, which were evidently but one story high. Such is the case with a pueblo built on the point of a *mesa* east of the Lower Verde settlement.

Furnaces, probably used for firing pottery, were discovered in some of these ruins. There is a very perfectly preserved one in a ruin on the right bank of Oak Creek, close to its junction with the Verde River, having walls standing to the height of fifteen to twenty feet.

Large pits are often seen in the vicinity of *casas*, whence the material used in making mortar was taken. The mortar used is of excellent quality, resembling fire-brick.

In concluding this brief sketch of the ancient remains of the Verde Valley, I would remark that they still present the most inviting field for the researches of the student of American anthropology and the included sciences of archæology and ethnology. From a merely superficial examination of their works much information has been derived concerning these remarkable cultures of our southwestern territory. In order that our knowledge of them may become as comprehensive as the material procurable for study will permit, it is desirable that a systematic exploration of these ruins be undertaken at once, either through private enterprise or by some one of the educational institutions of our country, before the treasures contained in them become scattered through the curiosity of unscientific relic-seekers. The writer's experience proves that an enormous mass of information and a large collection of valuable specimens would result from such an examination. Once possessed of these collected facts, it remains but to construct them by synthesis into a positive knowledge of much that relates to these people, than whom none are more interesting to the American anthropologist.

THE "EARTHLY TABERNACLE."

By OLIVE THORNE MILLER.

HOW to dispose of the earthly tabernacle after the spirit departs has always been a question of importance to the living. Some of the most imposing buildings in the world have been tombs; the pyramids of Egypt, and the Taj Mahal, that "dream in marble," will occur to every one. The widely prevalent notion that the dead require the conveniences needed in life, has preserved to us many relics of nations passed away, and to the habit of lavishing ornament upon places of burial we owe some of our finest specimens of early art. Even to this day, and in this Christian country, we attach an importance to the place and the manner of burial that seems hardly consistent with our professed belief that, in the words of the poet—

> "What the women lave
> For the last sleep of the grave,
> Is a tent that I am quitting;
> Is a garment no more fitting;
> Is a cage, from which at last
> Like a bird my soul hath passed."

The sentiment, however, did not begin nor does it end with
So far back as we find traces of man upon earth, so far also do
discover signs of his treatment of the empty "cage"; and down
this year of grace 1890 the customs of humanity are as vari
as curious, and as interesting as at any period in the worl
history.

In glancing over the subject, we find a noteworthy fact, th
whether the "garment no more fitting" be buried or burn
mummified, cast away, or eaten, some part of it is in almost eve
case preserved. With many peoples the chosen relic is the sk
which in Australia is made into a drinking-cup and kept fo
memento as well as a common convenience by the next of ki
in some parts of Polynesia the skull of the "dear departed"
hung around the neck of a widow by a cord, and worn duri
the rest of her life; and in one of the Kingsmill Islands it
oiled, decorated with flowers, and daily presented with food.

In some races the affectionate care of the survivors extends
all the bones, which are distributed among the friends, each o
of whom mourns over his one bone as if it were the whole bo
Again, they are arranged in various fanciful ways: tied in
bundle and painted red, by one tribe; packed in a basket de
rated with beads with the skull for a lid, by another; hu
from the roof, or placed in an urn, or wrapped in bark a
carried with the tribe; or, finally, painted in stripes and dri
in smoke.

Alexander the Great—as history tells us—was preserved
honey, and some of the royal Britons in wax; but the most famo
embalmers, as we all know, were the Egyptians. Would th
have taken so much pains, I wonder, if they had suspected th
were preparing curios for the museums of impertinent natio
yet unborn? Perhaps the most peculiar mode devised by man
the preservation of rich Thibetans in the form of cakes. T
empty "hut," being reduced by fire to ashes, is mixed with whe
flour and kneaded into cakes of graduated size, piled in a pyrami
and deposited in a small tower of suitable form.

Nearly all people cherish, in one way or another, the bones
their friends, and they may be conveniently divided into tw
great classes—those who take measures to dispose of the mo
perishable covering, and those who leave the work to the slow
processes of Nature. Among the first named are some excee
ingly strange customs: as that of the Caribs, who hang the emp
case in water infested by extremely voracious little fishes, and
a few hours draw up the skeleton perfectly cleaned, paint it re
and hang it under the roof of the hut; and, perhaps even le
agreeable, that not long ago in vogue among the Thibetans an
others, of keeping a race of sacred dogs for the special busine

of quickly disposing of the cast-off human garment; and, again, the habit of the ancient Persian, who invited wild beasts to the feast, and considered their speedy acceptance a special honor; most repulsive of all, some tribes of Tartars, and the Fans, an African people, who take upon themselves the delicate task of disposal—with pleasure, it is said. With this latter group must also be placed the ancient Irish and Briton, and many South American Indians. Most interesting of the practices of "living sepulchres" is that of the Parsees of India, whose famous Towers of Silence are well-arranged buildings where the necessary work is done quickly and unseen of men, by vultures "sent by God," as they say, and the bones preserved in one great central well together.

The most widely extended fashion of forcibly resolving the body into its elements is by burning, which has been in use almost from the beginning of man's life on this planet, and is to-day rapidly growing into favor with enlightened peoples. Before the advent of Christianity it was the nearly universal practice. The Greeks and Romans, the Etrurians, Hindoos, Siamese, Germans, Scandinavians, and Saxons, and many Indian tribes of the Western world, all burned their dead with more or less ceremony, and some of them do still. Certain Australians put the body in a hollow tree, and make of that a funeral pile; the Gualala of California burn the departed to prevent their becoming grizzly bears; and the Semels, another tribe, glorify their chiefs by great pyres heaped with finery and valuables, sometimes several hundred dollars' worth.

To the cremationists must be added many peoples of Asia, among whom the fashion is still in full vigor. Some races, both savage and civilized, sacrifice the living on the funeral pile, the victims being, of course, the helpless wives and servants. Most of them are merciful enough to strangle or otherwise kill the doomed ones, but it was reserved for the "mild and gentle Hindoo" to invent and carry out the most cruel and brutal custom on record.

Of the races who let Nature do the work at her leisure, perhaps the most striking are those who wall up the door and leave the deceased in possession, since this comes the nearest we can hope to get, to taking our riches with us. Such were the ancient Peruvian Incas, whose palaces were closed and deserted with all their treasures in them, although the dried and preserved body took its place with its ancestors in the Great Temple of the Sun, and the dying Eskimo left in his snow hut, with food and light at hand, free to depart when he chose.

Unique among men is one who saves his friends trouble by burying himself. The aged Australian, feeling death approach,

seeks out a hollow tree, climbs it, drops down inside, and is from that moment numbered among those who have "passed on."

Other methods are observed by the red men. Some of them are exposed to the winds of heaven, upon platforms raised on poles, as our own Dakotas, Blackfeet, Mandans, and some Sioux; others are placed in trees, like the Ahts of Vancouver's Island, where the height of the body indicates the social position of the departed; and not a few simply lay the cast-off "garment" on the bosom of its Mother Earth for the winds and storms to dispose of. In one place the body, in a canoe, is committed to the "mother of all things," the sea; and among the Hindoos it is often devoted to the sacred Ganges, lying on a platform with candles at the corners.

The largest number of civilized people, including all Christendom, bury in the earth, and, far less wise than the simple Indians whose ways we scorn, endeavor to keep as long as possible the "shell from which the pearl is gone" from its natural and much-to-be-desired fate, dispersal into the elements. This custom of burial arose partly from the desire of Christians to imitate the dead Christ, who—as a Jew—was buried; partly from a belief in the resurrection of the body, and also influenced, no doubt, by the difficulty during the early persecutions of performing Christian rites at a burning which must necessarily be public.

The curious and peculiar manners connected with burial in the earth are almost numberless, and edifying in the extreme. The position differs: some sit as in life, and others are held standing, though most lie naturally. The direction of the head varies. Many of our Indians turn the face to the west, toward their "happy land"; a few turn to the east. The dead Japanese heads toward the north, for which reason the living never sleep that way, and, to avoid the chance of it, carry a compass, or mark its points on their houses. The Bongos of Africa carry the distinctions of sex into the grave, and set the faces of men to the north and of women to the south; while the Niam-Niam, a neighboring tribe, consider the east the point of honor, and the west good enough for the weaker sex. Quaintest of all is the burial of an aged clergyman, a life-long pastor in an old-fashioned village on Long Island, who is laid with his feet toward his congregation, so that on the last day, when the trump shall sound, he may rise facing them as usual, and prepared to lead them, a united flock—*his* flock—into the Kingdom.

Urn burial has attracted much attention since it was brought prominently before the world at the Vienna Exposition some fifteen years ago. There had been a spasmodic revival of interest in this manner of disposal of the body both in France and Italy, but nothing of importance till this exposition. A warm convert,

Sir Henry Thompson, of England, wrote enthusiastic articles for the leading journals, and an earnest controversy was kept up for some time. The result has been discussion all over Europe and America, the establishment of cremation societies, and the building of crematories, for the new method differs greatly from the ancient fashion of burning on funeral pyres. The pyre, however, is still in use in India and other parts of the world, reaching its utmost extravagance in Siam, where bodies of the royal family are burned in gorgeous and elaborate temples built of wood and inflammable materials, but adorned and decorated, painted and gilded, to exactly represent their finest architecture.

There are many things to commend cremation aside from the pretty Indian fancy that fire, the purifier, completes the deliverance of the soul from its long-time prison of flesh, and by the smoke and ascending heat forms a path on which the spirit ascends to its home in the skies, or, as one tribe has it, the soft, warm chariot conveys the released and purified soul toward the sun.

We, of course, scoff at this, but there are potent arguments that should influence even our profound wisdom—sanitary reasons, the health of the living; economical reasons, the much-reduced expense; even sentimental reasons, the possibility of preserving the remains from desecrating touch. Most powerful of all in its favor is the prevention of premature burial. All these are on the side of cremation, and against it is but one—sentiment. It seems more beautiful to lay our friends to rest, softly pillowed, shrouded in satin, inclosed in rose-wood, covered with flowers, and of anything beyond we refuse to think. We erect the imposing marble, set out the blossoming plant, and carry flowers to the spot. The cemetery appeals more strongly to the sentiment than does the crematory. I find no fault with sentiment, but I say it will more appropriately cling around an urn containing the pure ashes of what was once a loved form than about the unmentionable and unimaginable horrors covered by our flowers.

Moreover, it is to be regretted that we can not rise to the height of Christian philosophy attained by one we call "heathen," and embodied in a poem, some lines of which are quoted above, with a few more of which I will close:

> "Loving friends! be wise, and dry
> Straightway every weeping eye.
> What ye lift upon the bier
> Is not worth a single tear.
> . . . . . .
> Cease your tears, and let it lie;
> It *was* mine, it is not I."

LIQUOR LAWS NOT SUMPTUARY.

By Rev. GEORGE F. MAGOUN, D. D.,
EX-PRESIDENT OF IOWA COLLEGE.

THE recent article * of William A. Hammond, M. D., on Sumptuary Laws and their Social Influence consists of two parts—(1) an attempt to confound laws prohibiting the common sale of alcoholic beverages with obsolete "sumptuary" legislation, and (2) certain criticisms in the same strain upon such laws in Iowa and Minnesota, and upon the New York and Michigan laws against the selling of cigarettes to minors. As no pretense is made of showing that the latter are "sumptuary," or that it is a tendency to luxury and expense which makes them a dead letter in the city of New York and elsewhere, they may be at once dismissed from consideration.† A long-time resident of Iowa has something to say in defense of the stigmatized statutes of his adopted State.

The sweeping assertion of Dr. Hammond is in the following terms:

"The laws which several States have enacted relative to the manufacture and sale of alcoholic liquors are true sumptuary laws, notwithstanding the fact that it is claimed by their adherents that they are measures which every independent State having a regard for the welfare of society is in duty bound to enforce." The first example given to sustain this is a law of Iowa, referred to (after descriptions of the sumptuary laws proper of Sparta, Rome, and England) thus:

"In our own country the experiment has been tried with as much thoroughness and with practically as little result as has attended the attempt by other nations" [i. e., to forbid the people

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* Popular Science Monthly for May, pp. 33–40.

† The following is credited in the public journals to Science: "In an experimental observation of thirty-eight boys, of all classes of society and of average health, who had been using tobacco for a period ranging from two months to two years, twenty-seven showed severe injury to the constitution and insufficient growth; thirty-two showed the existence of irregularity of the heart's action, disordered stomachs, coughs, and a craving for alcohol; thirteen had intermittency of the pulse, and one had consumption. After they had abandoned the use of tobacco, within six months' time one half were free from all their former symptoms, and the remainder had recovered by the end of the year."

It is certainly supposable that intelligent law-makers could enact a statute to prevent the sale of tobacco to boys from a humane and public-spirited motive without thinking of the pennies saved to the boys; and if the enforcement of the law saved their pennies, so much the better for the boys and no worse for the law. Any good citizen is therefore at liberty to hope for such a law and such enforcement as prevents the sale. As to these and a more recent law in New York, it might be instructive to know from the legislators whether they really enacted them from "sumptuary" considerations.

"to wear, to eat, and to drink what they please"]. "As early as the year 1639 we have the prototype of that curious law enacted a few years ago in the State of Iowa, which prohibits one person from inviting another to take a drink, or treating, as it is called."

A citation is then made from the records of the colony of Massachusetts of a statute for which four reasons are alleged, one of them being "much waste to the good creatures." This, and this alone, is a sumptuary reason. But the law cited—if it be one—is not simply and distinctively sumptuary, though such laws were passed by that and other colonies. For example, Virginia, in 1662, enacted the following:

"An Act * prohibiting the importation of unnecessary Commodities. *Whereas*, the low price of tobacco will hardly supply the urging and pressing necessities of the country, etc., . . . Be it *enacted* that no strong drink of what sort soever, nor silke stuffe in garments or in peeces (except for whoods and scarfes), nor silver or gold lace, nor bone lace of silk or thread, nor ribbands wrought with silver or gold in them, shall be brought into this country to sell, after the first of February next; under penalty of confiscation," etc.

So Massachusetts enacted in 1634 as follows:

"The Court, taking into consideration the greate, superfluous, and unnecessary expences occasioned by reason of some newe and immodest fashions, as also the ordinary weareing of silver, golde, and silke laces, girdles, hatbands, etc., hath therefore ordered that noe person, either man or woman, shall hereafter make or buy any apparell, either woollen, silke, or linnen, with any lace on it, silver, golde, silke or threed, under the penalty of forfeiture," etc. Subsequent provisions forbid any one to make "slashed cloathes," but allowed men and women "to weare out such apparell as they are nowe provided of (except the immoderate greate sleeves, rayles, longe-wings, etc.)." In 1636 a law was passed against making or selling any bone lace. In 1641 the General Court, noting excesses prevailing against enactment, ordered the constables of every town to see to its enforcement.†

Upon the face of them these are characteristically, simply, and only sumptuary prohibitions. Their one, immediate, and sole object is the prevention of private waste and expense. So Dr. Johnson, a century and a half ago, defined this class of statutes: "SUMPTUARY [*sumptuarius*, Lat.]: Relating to expense; regulating the cost of life." He quotes Bacon, a century

* Dr. J. Hammond Trumbull says: "This law is crossed with a pen on the MS. record: Jefferson '*conjectured* it was negatived by the Governor.'"

† That notorious liar, Rev. Samuel Peters, in his Blue Laws declares the penalty in Connecticut for wearing lace was "at £300 estate"—about as true history as the rest of his writings.

earlier, on "removing want and poverty" through "the repressi of waste and excess by sumptuary laws." The definition has ne changed down to our day. (Cf. Webster, Worcester, and othe So Skeat's Etymological Dictionary—"relating to expenses (It is rather Englished from Latin, *sumptuarius*, belonging to penses, than borrowed from the French. Formed from cru form of *sumptus*, expense, cost" [so "sumptuous"]. It is the fore simply evidence of lack of discrimination to call any la sumptuary one whose object is not the prevention of cost, pense, and waste. One might as correctly pronounce the proc mations in the colony of New York against any but the Du Reformed worship (1656, 1662), or those of Virginia agai absence from the Episcopal service (1623, 1652), or those of Ma land against blasphemy and denying the Trinity, and usi anything in public worship save the Book of Common Pra (1649, 1700), sumptuary laws as those of to-day against traffic in intoxicating beverages. They have nothing in comm The colony of Maryland provided that "every ordinary kee that shall demand or take above 10 lbs. of tobacco for a gallon small beer, 20 lbs. of tobacco for a gallon of strong beer, 4 lbs. a lodging, 12 lbs. for a peck of Indian corn or oats, 6 lbs. for night's grass for a horse, 10 lbs. for a night's hay or straw, sh forfeit for every such offense 500 lbs. of tobacco." It would be unnecessary blunder to assert that *this* had nothing to do wi restraining what was deemed undue cost of living and travelin But Maryland enacted the same year (1699) that "No inhabita of this Province shall sell without license any cider, quin drink, or other strong liquor, to be drunk in his or her hou upon penalty of 1,000 lbs. of tobacco for every conviction." the reason and principle of this the same with the reason a principle of measures adopted to keep down prices, such as se eral colonies adopted—e. g., that just cited, restraining innkeep from overcharges? Both are prohibitory. But is the restrai of *unlicensed* liquor-selling fitted to lower the prices of intoxica ing drinks, or—other things being equal—does the cost of a licen to sell tend to raise prices? If, then, this latter Maryland law cou not have been sumptuary, has not the free sale of intoxican been repressed, whether by license or prohibition, for other reaso —viz., those of public policy—that is to say, the duty of "eve independent State" to have "a regard for the welfare of society But this is just what Dr. Hammond takes it upon himself to s has *not* influenced the legislation of certain great commonwealt East and West, forbidding the sale and manufacture of alcoho beverages. Is it quite sure that he knows their ends and motiv better than they know them themselves?

The point will be made still clearer—if this is possible—

noting the ancient colonial legislation against liquor-selling, and judgments against drunkenness. 1630, Massachusetts: "It is ordered that all Rich: Clought's strong water shall presently be seazed upon, for his selling greate quantytie thereof to severall men's servants, *which was the occasion of much disorder, drunckenes, and misdemeanour.*" If we are to believe Dr. Hammond, "the Massachusetts Court of Assistants and General Court," who passed this order, either did not know why they passed it, or deliberately falsify the record, giving certain fictitious reasons for their action in place of the one constant, true one for all such action, known to Dr. Hammond now, but absent from the history of the case. This is reconstructing history with a vengeance. For our own part, we prefer to believe the Massachusetts actors and witnesses themselves. 1632: "It is ordered that the remainder of Mr. Allen's stronge water, being estimated about two gallands, shall be delivered into the hands of the deacons of Dorchester, for the benefit of the poore there, *for his selling of it dyvers tymes to such as were drunke with it*, hee knowing thereof." Neither the recording officer, nor the Dorchester deacons, nor the General Court, seem to have known that the real reason here was that those who made themselves drunk could not afford the expense!

Dr. Hammond gives a couple of instances of colonial punishment of drunkenness. Here are others. 1633. Massachusetts: Robert Coles fined £10 for "abusing himself shamefully with drink," and enjoined to stand with "A DRUNKARD" in great letters on a white sheet on his back, "soe longe as the Court thinks meete." [The penalties for repetition next year—disfranchisement, etc.—referred to by Dr. Hammond, were remitted, May, 1634, on submission and testimony of good behavior.] T. Hawkins and John Vauhan fined 20*s* for a similar offense and selling "strong water, contrary to an order of Court." In 1643 and 1650 the colony made the harboring of drunkards penal. But there is not the slightest evidence that the proceedings in these cases were for sumptuary reasons. 1639: Wm. C—— was fined 40*s*. "for misdemeanor in drinking, and corporal punishment remitted upon his promise to avoid such occasions." The same year, in New Haven, John Jenner, "accused of being drunk, was acquitted, it appearing to be of infirmity, and occasioned by the extremity of the cold." "Mr. Molenour, accused, but not clearly proved, was respited." It could hardly have been the object in these cases to prevent the expenditure for the liquor, or to dictate what the persons concerned should or should not drink! Nor when Thomas Frankland was punished "for drinking strong liquors to excess and entertaining disorderly persons into his cellar to drinking meetings." The First Code of Connecticut, 1650, mentions "divers abuses that

fall out by several persons that sell wine and strong water, as well in vessels on the river as also in several houses"; and the Orders of the General Court of Massachusetts, 1643, forbidding continuance "above half an hour at a time in any common victualing-house" for the purpose of tippling, justifies this "for the preventing that great abuse which is creeping in by excess in wine and strong waters." Were these bodies entirely mistaken in supposing they were actuated by "a regard for the welfare of society" instead of sumptuary considerations? On the other hand, in 1637 the record "it hath appeared unto this Court (Mass.), upon many sad complaints, that much drunkenness, *waste of the good creatures of God*, mispence of precious time, and other disorders have frequently fallen out in the inns and common victualing-houses," includes sumptuary considerations, with others (as did the prohibition two years later, cited by Dr. Hammond), as reasons for regulating the price of liquors and meals at inns.* Need any one confound this with laws simply to prevent drunkenness? Perhaps the confounding of these two different things has arisen from the mendacious forgery of Peters (Blue Laws, 26). "A drunkard shall have a master appointed by the selectmen, who are to debar him from the liberty of buying and selling" (published in 1781). Under the head of "Innkeepers," etc., the New Haven Laws and the First Connecticut Code provide penalties, ten shillings or less, for drunken behavior, etc., at inns, and for the "disorder, quarreling, or disturbance" resulting. And here the colonies—the Northern ones, for those of the South seem to have laid no such restriction—followed the laws of England; for example (4 James I, ch. 5) "Every person convicted of drunkenness shall forfeit, for every such offense, five shillings; and if unable to pay, shall be set in the stocks six hours." The law of Minnesota against drunkenness may be more severe in amount of penalty—"from ten to forty dollars for the first offense"—but is no more "sumptuary" than the old statute of James I—no more so than the French and German military prohibition of tobacco. Is it the expenditure made by the soldiers for cigars or cigarettes that these army orders are intended to prevent, or the unfitting of their nerves and muscles for military service? What an absurd bugbear the word "sumptuary" is, to be sure!

We can now readily see that the law of Iowa, twice referred to by Dr. Hammond, is not a sumptuary law at all; did not have for its prototype the partly sumptuary colonial enactment of Massachusetts of 1639, or the previous one of 1636; and is intemper-

* In an age when prices, wages, and expenses were regulated frequently by law, mixed regulations of this kind would naturally at times be passed; at present, when we have nothing of the kind, they would not be, and those of a totally different character can not be made such by construction or assertion. Cf. Maryland law, 1699, above.

ately stigmatized as "the height of human folly." One would think from his description—"it is made a penal offense for one person to ask another to take a drink"—that even in the "castle" of one's own home one can not do this in any circumstances—so eager are the Iowa law-makers to forbid the people "to wear, to eat, and to drink what they please." Passing the flippant tone in which it is asserted that a man who, "in the sanctity of his own house, gets quietly drunk and goes to bed," "has injured no living being but himself," it is to be said that there is nothing whatever in the penal features of the prohibitory statutes of Iowa that has anything to do with the "sideboard" in a private house.

It strikes one rather oddly, on the score of logical concinnity, that the prevention of a man's being "treated" to liquors, without any expense to himself, should be argued against as a "sumptuary" measure, whether the giving away of the liquors is done in a saloon or a parlor. A prejudice in favor of the free use and sale of intoxicants may indeed prevent one from seeing a ludicrous fallacy here.

A prohibition of giving away liquors to Indians, minors, and persons who are already intoxicated is quite an old affair in the Code of Iowa. It stands under the title "Offenses against Public Policy." To persons who have lived in States or Territories where Indians still linger it will be very clear at once what "public policy" has to do with it, and that the sumptuary question has nothing. A general provision years since against evasions required courts and juries to construe the whole chapter concerning intoxicating liquors "so as to cover the act of giving as well as selling by persons not authorized." Is not this according to public policy, anyway? Artful sales by pharmacists for other purposes than medicine were carefully provided against. Selling to voters within a mile of the polls during an election was forbidden, and the purity of elections further protected by forbidding to *give* them any intoxicants, including ale, wine, and beer. Is this any more sumptuary than making the sale unlawful within three miles of the State Agricultural College (save for sacramental, mechanical, medical, or culinary purposes), or within a hundred and sixty rods of any agricultural fair? On the other hand, all this was so far from interfering with the right of the people to drink what they please that the Iowa Supreme Court had decided that the act of giving is not in itself unlawful, that the keeping of liquors without intent to sell unlawfully is not affected, nor the character of liquors as property. "The statute," said Judge Beck, of the Supreme Court, in one case, "does not forbid the simple act of giving when no consideration, reward, or payment was given or promised, and none expected, and which was not intended as a subterfuge to conceal unlawful sales and evade

the penalties of the law." These things a
spirit of the legislators and judiciary of a
State. On these principles later enactment

But evasions of the law and the making
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General Assembly, to prevent other evasio
perverse ingenuity and against the weal
enacted what, I suppose, has called out t
mond to stigmatize all our prohibitory leg
It was this:

"After this act takes effect no person

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* Some anti-prohibitionists, for example, the present D
ernor of Iowa—the only State officer of this description, an
a generation—favor summary, or even severe, dealing with
ists agree with them in this substantially, and in not interf
to buy, while they differ with them as to repressing the sale
chief source of drunkenness.

The public prints within a few days contain the follow
surgeon will hardly pronounce "sumptuary"!

"The military commission of the Austrian army have esta
intoxication should be punished the first time by a public
by several days' imprisonment in the guard-house. The thi
victim is suffering from a chronic disease, and he is placed u
pay is taken out of his hands, and every means used to pre
secure spirits."

sale, *give away*, exchange, barter, or dispense any intoxicating liquor for any purpose whatever, otherwise than as provided in this act. Persons holding permits as herein provided shall be authorized to sell and dispense intoxicating liquors for pharmaceutical and medicinal purposes, and wine for sacramental purposes, but for no other purposes whatever."

I hope the terms of this statute make it sufficiently evident that the men who made and passed it were absolutely in downright earnest to suppress the wretched traffic in drunkard-making beverages, and I have not a word of apology to offer for them. This measure, to use Cromwellian phraseology, is one of "root-and-branch" extermination of a sore and fearful evil. But along with it should go the statement that this is but half of their legislation on the subject, the other half—known as the "Pharmacy Act"—being permissive of the sale of the same intoxicants, for the lawful purposes above named, by pharmacists, under restrictions. Some of these were by the last General Assembly relaxed, with no effect, however, upon the other half of the law, prohibiting sales of beverages by other persons. Step by step that has been allowed by law and that forbidden which long and disastrous experience showed might or must be. I am authorized to declare that neither this nor any other statute of Iowa is "sumptuary" in character or intent. I do not claim that all of them are perfect for their ends, but only that—a simple fact—this is in no instance among their ends. The giving away of means of intoxication included in the last recited statute (22 Gen. Assembly, chap. 71, § 1) is forbidden simply and solely to prevent evasions. Doubtless it will be condemned by those who are willing the risk of promoting drunkenness should be incurred by a liquor traffic more or less free; but, after this patient exhibition of authoritative facts, it should be forever impossible for any intelligent and candid man to stigmatize it as "sumptuary."*

After this refutation of its main contention, minor points, made in the same spirit in the article here criticised, hardly require notice. That "*no one* is safe under such a law" as that of Minnesota from arrest and penalty on the charge of his being drunk, will call out a smile among the sober people of that good State. That every law of this tenor is quite or "almost a dead letter" is —within the ordinary and daily observation of citizens in States where they are in force—absolutely contrary to fact. At the time of this writing the retail of drinks manufactured in other States is suddenly and notoriously increasing under the "original packages" decision of the Supreme Court of the United States. This

* No laws against the *evasion* of a statute can possibly be "sumptuary," unless the original statute is such, which in this case is not, as we have shown at large.

unhappy change is proof plenary of the wide departure fr truth, among other things, of assertions that sales were all t while going on, which have been suppressed and only now sumed. Such assertions have come chiefly from persons resid elsewhere, in the face of the testimony officially given by the G ernor of Iowa, judges, and other State officers. That there other offenses against society unpunished and unforbidden nothing to the purpose as to why liquor-selling is forbidden. advocates of temperance argue, in the way of philanthropic mo suasion, that "those who indulge in alcoholic liquors or toba spend money which could otherwise be more profitably used," is just what they should do; but in not even the smallest measu does it go to prove that laws devised for other objects were i tended, after all, though their authors do not know it, to preve this spending of money. If they have this effect incidentall so much the better for the money spenders and no worse for t law. Any good "social influence" of a Code of Criminal Pr cedure which provides penalties for such "Offences against Pu lic Policy" Dr. Hammond is precluded from recognizing by h assertion that they are null and void. What, then—should su offenses go scot free? What crimes, then, should be punished all? His boast of evading the law of Rhode Island "at a prom nent hotel" by a trick—be it professional or unprofessional—wi impunity* is certainly very good evidence that the law did n prohibit the private act of drinking, but the public act of sellin Does any law anywhere interfere with liberty of buying, save i the harangues of Personal Liberty Leagues? Prohibitionis everywhere disclaim such interference, but claim the right "every independent State" to suppress the common and publ sale of anything deemed detrimental to "the welfare of society Any argument against this has little weight, save with those w subordinate this "welfare" to personal convenience, and, mo over, goes too far in that it sanctions the open sale of powder a dynamite by anybody who sets up his "personal liberty" in th regard. The real objection of the free-sale advocates is to t actual obstacle "to get any kind of liquor a person wants" in a kind of "packages," and "as many more on the same terms," i. by some unlawful evasion—which obstacle is denied in the sam breath to exist! One horn or the other of the dilemma the adv cates of free sale should now choose, after so long playing pe dulum between the one and the other.

It is not a little surprising that under the head of "social in fluence" a stronger denial than this self-contradictory one is n made. It is here suggested gratuitously to the liquor interes

* Popular Science Monthly, May, p. 38.

When its advocates assert that those who are determined to have intoxicating beverages will get them, by hook and by crook, spite of all safeguards with which the public weal surrounds itself (an assertion equally strong against powder and dynamite laws, etc., and equally weak), they almost say, but not quite, that those are least prevented from buying who most need to be. This is quite true; but it is an inevitable incident, not of law, but of universal human perversity. There is no help for it save by making men perfect at once. In a prohibition State moderate drinkers will refrain from buying, while abandoned drunkards will buy through the unmanliest, the meanest, and basest expedients. So much the better for the moderate drinkers, anyway and at least, and no worse for the law. A multitude of such persons in Iowa and Kansas to-day praise the laws that protect them from their lower selves. Even our German fellow-citizens, with habits and prejudices brought from "Fatherland," very numerously do the same. But this alone is not the extent of public good secured. Hardened criminals of any sort, whom no law can reach, would soon disappear from natural causes were not their ranks replenished. The drunkards who will lie and cheat, and generally degrade themselves for the means to get drunk, in like manner would soon die out if not reformed. But they are replaced by new recruits from *the moderate drinkers alone;* and if these largely respect prohibitory laws, though the unhappy beings whom they are on the way to join do not, there will ere long be few to break these laws at all. Unwittingly, the assertion of liquor men that such laws are a "dead letter," so far as it is true—and this is far less than is asserted—only suggests another defense of these laws from their widely experienced "social influence."

One sometimes wonders why license laws, as well as prohibitory ones, are not denounced as "sumptuary"! The fact is, that their natural tendency is to increase the expense of both intemperance and moderate drinking—the liquor-vender charging more for what he sells to cover *his* expense for a license. This might in some small measure lessen buying, and expense with it, on the part of those who can least afford to buy. Would any one pretend that this is the object of license laws, rather than to balance the notorious injury done by the traffic to the State, by putting the license fees into its treasury? There is one obvious and nearer reason for not misrepresenting license laws as "sumptuary," viz., that however thoroughly enforced they may be, the means of securing the effects of intoxicating drinks, moderate or immoderate, are openly obtainable. Under prohibition, as well enforced, they are not.

It is to be noted that, if the Iowa Legislature had *not* provided by further legislation against evasions of its statutes (through

such subterfuges as club-room arrangements, treating, exchang barter, etc.), there might be some pretense that it is expense to t drinker which the Iowa law originally intended to prevent. B this can not be the object when the drinker is at no expense. A so the very statute preventing evasions assailed by Dr. Hammo goes to overthrow his contention, since the reason for preventi them can not be "sumptuary." There is an old saying abo hoisting one's self with "his own petard."

THE MIGRATION OF SYMBOLS.

By the COUNT GOBLET D'ALVIELLA.

II.

SYMBOLS may differ in aspect and yet be connected with on another by a more or less direct affiliation. This thoug leads us to examine the causes which may change the forms symbolical representations. There is first a tendency to reduce simplify the figure, in order to confine it to a smaller space or t diminish the labor of the artist—especially when the figure i complicated and frequently used. In all the systems of writin in which the characters began as hieroglyphics, we have only t scratch the letter to find the hieroglyphic symbol. Thus ou vowel A was originally the head of an ox, and that in its tur represented the whole animal, according to the popular rule tha in symbols and sacrifices a part may stand for the whole. S likewise, in the signs of the zodiac, the lion is simply represente by his tail. At other times, again, additions and embellishment are dictated by æsthetic considerations. That was the case wit most of the symbols adopted by Greece, whose art, so strongl original, never adopted foreign types without impressing pro found and felicitous modifications upon them.

The caduceus did not always present the classical form of tw serpents symmetrically entwined around a winged rod. On th oldest monuments it is a stick the knotty head of which fork into two branches that curve round till they recross one anothe then diverge and approach again, so as to form a figure 8 place at the end of a rod and open at the top. The poems of Home disclose to us an epoch still more remote, when a simple flowerin rod with three leaves was attributed to Mercury. In seeking a explanation of these transformations, we suppose that the first i date was probably due to the influence of the Phœnicians, wh left on their steles, especially in Libya, the representation of nu merous caduceuses formed of a circle placed upon a stick and sur mounted by a crescent. It is open to discussion whether the sec

ond modification—which was justified after the event by the legend of Mercury throwing down his rod between two fighting serpents—reveals a symbolic intent, or is due, as most of the learned think, to a fancy of Greek art. But, in either case, the innovation made it possible for the caduceus to be preserved in modern symbolism to represent the two ever-present attributes of Mercury—Industry and Commerce. In like manner it has been perpetuated in India, where it was introduced by the Greeks, till our time; and M. Guimet observed numerous examples of it among the votive offerings in some of the Vishnuite temples. Nothing is lost in symbolism that is worthy to live and can be transformed.

Symbols are also subject to the law of the struggle for existence. It was artistic perfection that secured the longevity of the thunderbolt—another figure which was long believed to be of Hellenic origin. Nearly all peoples have represented the fire from the sky by an arm, sometimes also by a bird of strong and rapid flight. It was symbolized among the Chaldeans by a trident. Cylinders going back to the most ancient ages of Chaldean art exhibit a water-jet gushing from a trident which is held by the god of the sky or of the storm. The Assyrian artist who first, on the bas-reliefs of Nimroud or Malthaï, doubled the trident or transformed it into a trifid fascicle, docile to the refinements and elegancies of classic art, by that means secured for the ancient Mesopotamian symbol the advantage over all the other representations of thunder with which it could compete. The Greeks, like the other Indo-European nations, seem to have represented the storm-fire under the features of a bird of prey. When they received the Asiatic figure of the thunderbolt, they put it in the eagle's claws and made of it the scepter of Zeus, explaining the combination, after their habit, by the story of the eagle bringing thunder to Zeus when he was preparing for the war against the Titans. Latin Italy transmitted the thunderbolt to Gaul, where, in the last centuries of paganism, it alternated, on the Gallo-Roman monuments, with the two-headed hammer. It is also found on amulets of Germany, Scandinavia, and Brittany. In the East it penetrated to India, following Alexander, where it is found competing with other symbols having the same significance. Siva, who succeeded Zeus on the coins of the Indo-Scythian kings, after the light of Grecian civilization was extinguished in the Northeast and in India, holds in his hand sometimes the thunderbolt and sometimes the trident; and while the latter remains exclusively the arm of the god in the later imagery of the Hindoo sects, the thunderbolt found its way to the Buddhists, who carried it with their symbolism to China and Japan. It is still met under the form of the *dordj*, a little bronze instrument in the shape of a

double fascicle of six or eight arrows, which, held between the thumb and forefinger, is used by the lamas and bonzes in blessing the faithful and exorcising demons.

By the side of the improvements due to the aspirations of artists must be placed the deformations produced by the ignorance or unskillfulness of copyists. Sometimes a new type springs from these deteriorations to succeed the old one in somewhat the same manner as in the dissolving views, where the outlines of two pictures succeeding one another are confounded into an indistinct image which is neither one nor the other. The ansate cross of the Egyptians seems thus to have engendered certain types of the Ephesian Diana, with veiled face, arms half opened, and body inclosed in a sheath; as also the sacred triangle of the Semites, frequently surmounted by a disk and two horizontal bars, inspired in the Greeks, according to François Lenormant, representations of Harmony or of Aphrodite under the form of a cone crowned with a tiara and supplied with two rudimentary arms. As a counterpart to these metamorphoses changing a linear symbol into a representation of the human figure, may be cited some images sculptured on the paddles of the New-Irelanders, which were exhibited at the meeting of the British Association in 1872. There was revealed in them a series of deformations gradually changing a human face into a crescent couchant on the point of an arrow. Except for the presence of the intermediate forms, no one would have inferred the relationship of the extreme terms.

When the symbol is composed of several images grouped together, there is no reason why it should not keep its physiognomy as a whole, although one or more of its constituent elements may be modified, the better to answer to the religious traditions, the national preferences, and the geographical peculiarities of a new medium. Thus the lily, as M. de Gubernatis remarks in his Mythologie des Plantes, has taken the place of the lotus in the symbolic combinations borrowed by the West from the East. One of the most characteristic examples of these local variations with persistence of the type is presented to us by the figured representations of the sacred trees, in which we believe we can recognize the tree of life which is mentioned in both the Semitic and the Aryan traditions. From the most remote antiquity, the Chaldeans gave it the appearance of the date-palm, sometimes attended by a vine or an asclepiad similar to the plant that yields the *soma* of the Hindoos. The Assyrians made of it a wholly conventional tree, in which palm-leaves were associated with a cone-fruit, and the horns of the wild goat formed a kind of capital to the trunk. The Phœnicians exaggerated the artificial character of the representation by grafting the flowers of the lotus upon it. The Greeks introduced it into their ornamentation under the abbreviated

form of the palm-leaf or acanthus. The Persians adopted it with the conventional physiognomy which the Assyrians had impressed upon it, and it was thus carried to India, where the Buddhists substituted for it the sacred fig-tree of Buddha. On the other side, the Persians bequeathed it to the Arabs, who, stripping it of its religious signification, retained it as an ornament in the decoration of their jewels and cloths. Finally, reaching Europe in the middle ages, with cloths of Oriental origin, it was reproduced among the sculptures of some churches, where it represented sometimes the tree of the cross, sometimes, by a curious coincidence, the tree of life of the biblical traditions. In all these variations of the same theme, the plant constitutes only a part of the symbol. That is completed and characterized by the presence of two personages confronting one another—genii, demons, wild or fanciful animals, monsters half beast and half man, between which the sacred tree raises its stem or spreads its branches. Nothing more is needed to establish the affiliations of this complex image which brings into connection, through many thousand years, the Chaldean cylinders and the medallions of the Javanese pagodas, the Greek capitals of the Didymeon and the Christian tympans of Calvados and Gloucestershire.

A frequent cause of alteration, to which sufficient attention has not yet been given in the study of symbols, is the attraction which some figures exercise upon others. We can almost announce under the form of a law that when two symbols express the same idea or near ideas they manifest a tendency to combine so as to engender an intermediate type. For want of understanding that a symbol can thus be connected with several figures very different in origin and aspect, many archæologists have lost their time in disputing upon the origin of an image or of a sign which each of the parties had reason to connect with a distinct antecedent—like the knights in the legend who broke lances over the color of a shield of which one saw one side of one color and the other the reverse of another color.

Examples of such real symbolic transmutations are too numerous to be recited here. A simple and salient form of them is given in the wheel, which, possessing the double advantage of having a circular form and of implicating the idea of motion, is one of the most frequent symbols of the sun. When that star was likewise symbolized by an open flower, the effort was often made to fuse the two images. Thus, in the bas-reliefs of Buddhist India we find wheels the spokes of which are replaced by lotus-petals; while in the island of Cyprus there are coins bearing roses the leaves of which are encircled by twisted rays, or arranged in the form of a wheel. The special amulet of the Gauls, the solar *rouelle*, easily furnished, on the advent of Christianity, the

chrisme or monogram of Christ (X and P interlaced) by the simple addition of a loop.* In a similar way the *chrisme* becomes the ansated cross or key of life, through a series of transformations which are found among the inscriptions of the island of Philæ.

It is not even necessary that the symbols thus combined shall originally have possessed the slightest analogy of forms. There are certainly not many traits common to the different images of the sun in the valley of the Nile, where it is represented, according to the districts, as a radiating disk, a hawk, a goat, etc. But the Egyptians not only succeeded in condensing all these figures into the winged globe of their pylons and their cornices, but they also contrived to give the strange amalgamation the features of another solar animal, the flying scarabæus. When the winged globe passed from Egypt into Asia, the Assyrians in turn inclosed in the Egyptian disk the figure of their god Assur, which they represented as a winged genius, and till then the ancient sacred bird of Chaldea, which, according to M. Menant, contributed with the Mesopotamians to form the definite type of their winged disk, was not. Some of the coins of Asia Minor help us to comprehend the different processes by the aid of which the two symbols could thus be combined, if not also the principal stages of the operation by which they produced a third. The sun was often symbolized in Asia Minor by a *triscele*—that is, a disk around which radiated three legs joined at the thigh; at other times it was represented there, as in Egypt, by animals like the lion, the boar, the eagle, the dragon, and the cock. A coin of Aspendus in Pamphylia shows the cock in the field, by the side of the *triscele;* other pieces of the same origin show the *triscele* placed over or joined to the body of the animal without its losing its natural appearance. Finally, in a Lycian coinage, in the British Museum, the two symbols, at first placed together, then joined, are literally fused into one another; the three legs of the *triscele* are metamorphosed into three cocks' heads, which are grouped in the same way around a center.

Most frequently the symbolical syncretism is conscious and premeditated, whether the matter be one of the union for greater efficacy of the attributes of several divinities into a single talisman, or one of affirming, by the fusion of symbols, the unity of the gods and the identity of cults. Of such character were the talismans called *panthei*, with which the Gnostics endeavored to condense the divine symbols supplied by the principal religions

* M. Gaidoz, in his book on the Gallic God of the Sun and the Symbolism of the Wheel (*Le Dieu Gaulois du Soleil et le Symbolisme de la Roue*), defines the *chrisme* as "a wheel with six rays without the circumference, and with a loop on the top of the staff in the middle." It should be added that even in the catacombs the *chrisme* is sometimes drawn within a circle.

of their time. Of a higher order of ideas was the symbol adopted by the Brahmanists of the New Dispensation—the Brahmo-Somaj—who presumed to fuse all the existing sects of India into a new religion, founded exclusively on conscience and reason. The pediments of their temples bear a design in which the mystic syllable of the Brahmans, *Aum*, is interlaced with the Mussulman crescent, the Sivaite trident, and the Christian cross. It also frequently happens that this confusion of symbols is not at all systematic. By virtue of reproducing certain forms, the eye and the hand seem to be assimilated to them to such a degree that they are not able to rid themselves of the obsession when they attack new themes. There is a symbol of this kind, engraved on Phœnician gems or painted on Cypriote vases, which recalls the winged disk of Asia, the sacred tree of the Assyrians, and some of the Greek thunderbolts. One can not turn the leaves of the description of the Buddhist bas-reliefs of Boro Boudour, in the island of Java, published under the direction of the Dutch Government, without being struck, at almost every page of the Atlas, by the appearance of some curious figure which presents at once reminiscences of the Hindoo lotus, the Assyrian horns, the Greek thunderbolt, the Buddhist fig-tree, and the Egyptian globe with the Uræus. Such heteroclite mixtures have, moreover, been customary in Oriental symbolism. Sir George Birdwood, an author among the best versed in the industrial arts of modern India, has recently shown that in the Hindoo art, in which all the details have a symbolical bearing, certain decorative themes are combined and exchanged with the disorder of a dream, without regard to the distinction of the animal and vegetable kingdoms, or of the organic and inorganic worlds.

In most of the examples that I have cited it is easy to discover by what ways the symbol was transmitted from one people to another. Under this relation the migration of symbols rises directly from what may be named the history of commercial relations. Whatever may be the resemblance of form and signification between two symbolical figures, found among peoples of distinct origin, it is proper, before asserting relationship, to determine the probability, or at least the possibility, of international relations that may have served as a vehicle for them. This point fixed, it remains to be determined which has been the borrower and which the lender. Thus, why was it not the Hindoos who communicated the thunderbolt to Mesopotamia, the Phœnicians who received the caduceus from Greece? Here our advantages over preceding generations appear. There was a time when we might indistinctly place in India the origin of the gods, myths, and symbols that are scattered all over the world; another when it would have had a bad air not to give Greece credit for

all intellectual and religious creations that had any moral or artistic value. But the investigations of the last half-century have given positive bases for the ancient history of the East; and that in turn permits us to restore to their true plane in the perspective of the ages the principal centers of artistic culture which have reacted upon one another since the beginning of civilization.

There may be differences of opinion as to whether the Ionic capital borrowed its volutes from the horns of the ibex or the half-opened petals of the lotus. There may be discussion as to whether Ionia received it directly from Golgos on the Phœnician vessels, or from Pteria with the caravans of Asia Minor. But no one who has observed its presence on the monuments of Khorsabad and Koyoundjik will refuse to locate in Mesopotamia the point of its departure toward the Ægean Sea. This is only an example of the types and motives the development to importance of which is doubtless due to the autonomous inspirations of Greek genius, but the origins of which are to be sought in Phrygia, Lycia, Phœnicia, and beyond, in the valleys of the Tigris and the Nile. In India, likewise, the most ancient works of sculpture and carving—wherever they do not attest a direct influence of Greek art—associate themselves with the monuments of Persia by the adoption of motives in some way classic in the Persepolitan architecture—like the capitals formed of animals sometimes affronted, sometimes backed; which are, as a plastic signature, in the former case of Assyria, in the second case of Egypt. In fact, when we depart from Greece or India, or even Libya, Etruria, or Gaul, we always come at the end, stage by stage, upon two grand centers of artistic diffusion, partially irreducible to one another—Egypt and Chaldea; but with this difference between them: that about the eighth century before our era, Mesopotamia went to school to the Egyptians, while Egypt never went to school to any one. Now, symbols have not only, as we have shown more than once in the course of this study, followed the same routes as purely decorative themes, but they have also been transmitted in the same fashion, at the same times, and, we might say, in the same proportion. I am far from disputing that there may have been independent and autonomous centers of creation among nearly all peoples. But, besides autochthonous types, we find everywhere the deposits of a strong current whose more or less remote origins lay in the symbolism of the shores of the Euphrates and the Nile. In short, the two orders of importations are so connected that in writing the history of art we write in great part the history of symbols, or at least of their migrations—as is exemplified in the studies of MM. Perrot and Chipiez in the history of ancient art.

A distinction, however, should be observed, in researches rela-

tive to symbols, that form is not all. It is the intention that makes the symbol, and by this symbolism is dependent upon psychology, at the same time that its history deserves a place by itself in the general picture of the development of human civilization. A word is to be said from this point of view concerning other migrations; those in which a symbol passes, no longer from one country to another, but, upon the same soil, from one religion to the one that succeeds it. In the most frequent case, it is popular pressure that introduces into the new civilization symbols consecrated by long veneration. Sometimes the innovators themselves use the advantages offered by symbolism to disguise the novelty of their doctrine under ancient forms, and, when necessary, to transform into allies emblems or traditions which they are not able to destroy by a direct attack. Thus Constantine chose as his standard the *Labarum*, which could be claimed at once by the worship of Christ and by that of the sun. The same policy was attributed to the first king of Norway. According to an old song of the Shetland Islands, Hakon Adalsteinfostri, compelled to drink to Odin at an official banquet, drew the sign of the cross on his cup, and, when his guests reproached him for it, told them that it was the sign of the hammer of Thor. We know, in fact, that in German and Scandinavian countries the cross of Christ was more than once disguised under the form of a two-headed hammer, and that in more than one inscription in Egypt it put on the appearance of the key of life.

Such symbolical adaptations have been especially frequent in Buddhism, which has never been restrained from adopting the symbols and even the rites of anterior or neighboring religions. In some of its sanctuaries it has gone so far as to carve the ceremonies of the worship which natives of India gave to the sun, fire, and serpents, and connect such rites with its own traditions. The solar wheel thus became the wheel of the law; the sacred tree represented the tree of knowledge under which Sakya-Muni attained perfect illumination; the serpent *Naza* was transformed into a guardian of the footprints of Vishnu, which were afterward attributed to Buddha. Some years ago the remains of a Buddhist sanctuary were discovered at Bharut, in which the bas-reliefs represented emblems and religious scenes, accompanied by inscribed legends. The news gave great joy to the Anglo-Indian archæologists. They expected to be given interpretations of Buddhist rites and symbols, formulated by the Buddhists themselves one or two centuries before the Christian era. But a closer examination showed that the shrine was only an ancient temple of the sun, which had been taken possession of by the Buddhists. They were satisfied to put over the pictures of solar worship inscriptions connecting them with their own faith.

It has been said that religions change, but worship contin
the same. The assertion in this shape is too absolute; but i
certain that every religion preserves in its rites and symbols s
vivals from the whole series of previous religions. And this d
it no harm. The important thing is, not the leather bottle,
the wine that is poured out of it; not the form, but the thou
that animates it and goes beyond it. When Christians and B
dhists respectively concentrate upon their Master the princi
attributes of the sun, beginning with the nimbus, the prototy
of which goes back to the aureoles engraved upon the Chald
monuments, they do not suppose themselves to be giving hom
to the star of day. They only intend, in reality, to reflect upon
venerated face of their founder the symbol which has from ti
immemorial formed an image of the celestial glory, and wh
also, in contemporary cults, specially characterized the highest p
sonification of divinity. We are reminded of the answer whic
father in the Church gave to those who accused the Christians
celebrating the day of the sun: "We solemnize this day, not, li
the infidels, on account of the sun, but on account of him w
made the sun." Constantine went further when he composed
prayer for his legions to recite on Sunday that could satisfy
ones, as M. V. Duruy remarks, the worshipers of Mithra, Serap
the sun, and Christ. Symbolism may ally itself with the mo
mystic tendencies, but, like mysticism, it is a powerful auxilia
of the religious sentiment against the immobility of dogma an
the tyranny of the letter. M. Anatole Leroy-Beaulieu has show
pertinently to this point, how in Russia the conservative ritua
ism of the old believers has been able, by means of the symbolic
interpretation of texts and ceremonies, to attain liberty of do
trines and, in certain cases, a complete rationalism, without breal
ing with the traditional forms of Christianity or of the Easte
Church.

There comes a time when religions which make an importa
factor of the supernatural find themselves in conflict with th
progress of knowledge, and especially with a growing belief in
rational order of the universe. Symbolism then offers them a wa
of safety which they have more than once taken advantage of t
keep pace with their times. If we take peoples in an inferior d
gree of religious development, we find them having fetiches—th
is, beings and objects arbitrarily invested with superhuman facu
ties; then idols, or fetiches carved into resemblance of a man o
an animal; but we rarely discover symbols among them, for the
imply both the desire to represent the abstract by the concrete an
the consciousness that there is no identity between the symbo
and the reality for which it stands. When the mind opens to th
notion of abstract or invisible gods, it can preserve its veneratio

for its ancient fetiches, which are thenceforth regarded as representative signs of the divinities. Finally, when we come to conceive a Supreme God, of whom the old divinities are simply ministers or hypostases, the ancient figurative representations may still have a place, provided they are put in relation with the qualities or attributes of the superior being into which the divine world resolves itself. This is an evolution of which traces are observed almost everywhere in ancient polytheism. Dogmas and sacraments can always, on their side, be brought by symbolism into an interpretation harmonious with the progress of knowledge and reason. Such is the task to which are devoted—after Schelling and Hegel in Germany, and Coleridge and Maurice in England—a notable fraction of Protestant theologians, with a success which would doubtless have been greater if the school had not broken with the laws of historical truth by persisting in projecting into the past interpretations inspired by the present.

A religious condition may be conceived in which all cults become purely symbolical. There will be nothing to hinder their preserving with a pious care the rites and traditions of their heritage; only they will make of them particularly symbols of the truths common to all religions, and will consequently be able to treat one another—as we see in the rites of certain churches—as local forms and equally legitimate in the universal religion.

Such a syncretism looks, at first sight, to be very far from us. It would imply that all religions have their share of the truth, but that none possesses it all. This is hardly the language of the larger contemporary churches, if we may judge by those that touch us most nearly. But it must be observed that, in practice, their adepts live among one another as if the divergence in doctrines were reduced to a diversity of symbols. At times we see their chiefs—a thing unheard of in former centuries—co-operating on a footing of equality in works of philanthropy or social peace, as if they recognized that charity and justice afford a common ground for religious activity. Lastly, the attribution of a relative value—or symbolic, which is the same thing—to all cults indistinguishably may serve hereafter as a basis for the normal relations of the state with the churches in the countries which are under the influence of modern law. Let this idea, already anchored in our laws and our customs, be accepted in our consciousness, and for the first time in history the world will be able to enjoy a religious peace, founded not on the unity of forms and formulas, but upon the admission of what, under variety of symbols, is true and fruitful in all religions.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

MOTHERS AND NATURAL SCIENCE.

By MARY ALLING ABER.

A ROBIN teaches its own young to fly; a human mother often leaves the training of her babies exclusively to others. The bond of nature between the mother and child puts a premium on all that the mother does, and her constant association is an opportunity for understanding the peculiarities and needs of the child such as no ordinary teacher ever obtains.

As one's finger may trace in the yielding soil a channel for the outflow of a tiny spring, and at its fountain-head determine the course of a river, so, in the earliest years, the mother may, with little effort, give direction to the energies of the child. The mother's capacities, education, and circumstances may not permit her to accompany the child far on its course, or to contribute much to the current of its intellectual life; but let her give the direction and all the powers of nature will conspire with the child's inborn force to increase the volume and strength of the on-rushing stream.

To claim for natural-science studies the mother's power of direction, to show why mothers should interest their children in these studies, and to suggest how they may do so, is the purpose of this paper.

What mothers may do to interest children in natural science is a question which has but one answer—they may do everything; what mothers can do has as many answers as there are mothers. Between the may and the can is but one barrier—difficult to destroy—the mother's own habits of thought. Not ignorance, not scarcity of materials, not want of books—not all of these combined need long block the way of any mother whose mind still has the suppleness and sincerity of childhood; for the door into this kingdom of nature, like that into the kingdom of righteousness, is the simplicity of childhood.

It would be well, in these days of the supremacy of the material life and of increasing demands for applied science, if young women who are pursuing courses at our colleges would more often elect science studies, that they may be ready, by power to teach and by assistance and appreciation given to others, to further the introduction and pursuit of science studies in all lower schools; and to do this in a manner which shall help to put science in its true place as the handmaid, and not the destroyer, of religion.

But it is to those who have passed their school and college days that this paper must be addressed. As no body gets so stiff that proper treatment can not restore some of its lost pliancy, so

no mind is so helplessly set that it can not be drawn forth and directed into other molds. What a mother can do to interest her children in natural science depends upon her power to direct herself and to master the conditions of her life. Suppose that power is sufficient, how shall she begin? A mother may think that she needs trained guides, lest she make mistakes and waste precious time and strength. She may wish to know what materials to collect, what books to buy, when and where to get the materials and books, how much time and money they will cost, and what she is to do with them when obtained. Every mother has a right to ask these questions of any one who urges her to undertake to awaken in her children a vital interest in Nature's phenomena; but all that the writer of this paper can hope to do is to give suggestions which may lead a mother to find elsewhere the definite answers required.

A mother may begin to study with her children the ever-changing phenomena that surround daily life. The house is full of lessons. Various departments of science have contributed to its building and furnishing. There is scarcely an industry that is not represented in some room; the kitchen is a laboratory in which the truths of chemistry and physics are illustrated, and the table is supplied with gifts from the three kingdoms of nature; and to produce these, to transport them, and to prepare them for use, numberless natural agents have worked tirelessly and long. And out of doors—Nature's phenomena—where are they not? The snow and rain bring them; the ice locks them across the pond and the south wind picks the lock, the breezes blow them, the birds sing them, the brooks murmur them; every tree and flower, every stone and clod wait to tell their story; the waves wash their treasures to the shore; the rainbow is their expression; the glories of morning and evening write them on the sky; the sunlight comes and goes, bringing the wonders of night and day, of storms and seasons; and all night the stars speak of times and spaces our mathematics can not yet compute, and of events before which our short earth-lives shrink into nothingness.

What shall a mother take from this vast store to give to her children? Before answering this question it is proper to consider what purpose natural-science studies may serve in the education of a child; and to do this, the objects of education itself must be known. The supreme object of education is, without doubt, the development of the individual to the utmost limits his consciousness can grasp in this earth-life; some of the lesser objects are a vocation and success in it, pleasant social relations, ability to help the unfortunate, interest in national affairs, and a love of the virtues; and all these may be included under the expression

to be a good citizen. These objects imply health and industry, that the man or woman may be a producer and not a consumer only; sufficient intelligence to recognize and perform duties to one's self, to one's neighbors, and to the State; speech which is honorable and pure; and deeds which inculcate respect for the laws. Besides these, a mother may wish her child to acquire those graces of mind and heart that are difficult to define in words, but whose presence or absence is easy to feel in a man or woman; those graces which lift their possessor above the power of petty passions, of foolish conventionalities, above even the necessity to forgive injuries.

Emerson, in speaking of Lincoln, said: "His heart was as great as the world, but in it there was no room for the memory of a wrong." From the days of early manhood to the crowning act of his life, what a succession of kindly deeds are found in Lincoln's history! As the mind dwells on them, the great Proclamation is seen to be but the consummate flower on a plant which could bear no other. Such men do not fail when the time for great action comes. They do without fear what lesser men shrink from, or dally with, until the time for action has passed. No small soul, no life full of petty motives, ever rises to a great emergency. To one who meets the details of every-day life with a vain, selfish spirit the great occasion may come; but his will not be the honor of seeing it and of using it worthily. So, if a mother would have her children become men and women of the larger type, she must look well to "the reiterated choice of good or evil which gradually determines character."

What can natural sciences do toward this character-building? Have not studies other uses? Yes; but, while serving other uses, a study which does not mold character is of small value. This character-building receives little or no consideration in much that passes for education—a mistake from which the whole after-life of the child suffers. There is at present a "craze for information," as though to be a store-house of facts were a thing desirable in itself. Information so assimilated as to be a source of ready power in thought and conduct is a great good, but unless so available it is of little value. The mere desire for getting information might well be called intellectual avarice, for he who seeks this alone is almost as useless and miserable as the more sordid hoarder of money. Also, there is an idea, somewhat current in these days, that for children study should be transformed into play. I must protest against any such notion. Hard, patient, honest work is needed. The child who plays at his studies will play at life, play at everything, and will probably carry from cradle to grave the deception that whatever does not furnish him amusement is of no value, that work belongs of right

only to those miserable beings who have little capacity for amusement. There should be much delight in study, but there will be disagreeable drudgery as well, and any training is false which does not teach the child to do the drudgery promptly and faithfully. A mother who saves her child from disagreeable tasks does him the grave injury of sending him forth into adult life without the fixed habits which will enable him to meet its responsibilities with ease and dignity.

Now, for all this development of a child into a worthy man or woman natural-science studies have peculiar fitness. To secure and preserve health, considerable knowledge of these studies is a necessity; and their relations to preparation for self-support are obvious. In the proper pursuit of natural-science studies the capacities for accurate observation, for painstaking experiment, and for unbiased sincerity are developed; and without these capacities there can be no true progress in them. A slight prejudice introduced as a factor in estimating the results of a series of observations will vitiate the result, and may ruin the value of the whole work. Natural-science studies are as exact as mathematics in demanding obedience to their own laws. Reflection upon these considerations will show their value for intellectual development and training. The moral and spiritual influence of these studies is not less great. A child learns to be truthful in the presence of truth that never swerves; learns to be gentle when at work where one rude touch may destroy the labor of weeks; to be brave when he sees the struggle which everything in Nature makes for its own development; to be patient in waiting for Nature's slow processes; persevering when he sees that she gives up her secrets after repeated efforts only, often to be made under circumstances appalling to a spirit less mighty than her own; modest when he and his little come into daily comparison with her and her abundance; obedient when he sees that obedience to law brings beauty, pleasure, and life, and disobedience brings deformity, sorrow, and death; reverent before the majesty and power and glory of Him who is the life of Nature; generous, because she pours out her whole wealth to-day, never fearing that the morrow will not care for itself; joyous, because above all her struggle and pain rises a perpetual pæan of triumph.

If convinced that natural-science studies have special fitness for the training of children, with what study shall a mother begin to work? Although Nature herself indicates an order which may be pursued with advantage, this order is not so important that it need be attempted where conditions do not favor it. This order takes, first, rocks and soils, with enough of chemistry and physics to explain some processes of soil and rock making; second, plants, as depending on soil, air, and sunlight; third, animal life; and

fourth, man's structure. After this order has been observ
through an elementary course—just enough to give a hint of t
cycle of change from the rock world through the soil, plant, a
animal, back to soil and rock again, to show the intimate
pendence of Nature's kingdoms and processes—these studies m
be carried on together, a few weeks of each year being devoted
each one. This may be done until the student has reached t
years when he may wisely devote himself to one branch as
specialty. Attention to the whole cycle of Nature is not inco
sistent with thoroughness, since the little that is selected fro
each part may be thoroughly studied. A little work well done
of more value than to run over the whole field superficially, n
only to the contents of the child's mind, but to his growth
character.

It matters little where one begins, so that the study be hone
and thorough. Any beginning will lead everywhere else, fo
though there are straight roads for the specialists to follow, th
whole field is covered by a most intricate network of roads.
mother may begin where her present knowledge is least liable t
blunder. If she had a fondness for physics in her school day
let her take that. Let her teach her child the laws of mechanic
as illustrated in his daily life and observations. Let her teac
him to drive a nail properly, and she teaches him to avoid th
working of the law of the wedge; teach him how the window
are hung, and she introduces him to weights and pulleys; sho
him a man unloading a barrel of flour at the door, and she show
him the inclined plane; in teaching him to use a pair of scale
a can-opener, a claw-hammer, a nut-cracker, she teaches him th
use of levers. The wheel and axle may be taught from the wel
or the clock.

The properties of bodies and the laws of expansion and con
traction find abundant illustration in the daily life. Let the chil
fill an old jug with water, cork it tightly, and set it out of door
some cold night. The break found the next morning will not b
forgotten. Then take him to a neighboring ledge of rock, sho
him its cracks filled with ice, and he will not be slow to draw th
lesson of how the strong rocks are broken asunder. Then sho
the child the tiny snow-flake with its six crystal arms, so delicat
that you hold your breath lest they vanish while you look; an
lead him to see that the jug and the mighty ledge of rocks ar
broken by these fairy creatures. What tale in mythology o
folk-lore is more wonderful than this? In every drop of wate
is the fairy crystal spirit, but it can not embody itself wher
heat is. Cold is its good genius; and when cold comes, the fairy
spirit works, throwing out one dainty spar after another and in
terlacing them with threads more delicate than those in our fines

laces; and the fairy spirit has a body; the crystal exists. But if the water is confined and has not room enough, why, these frail things break the bond, break the jug, break the giant rocks. If this story is well taught, the child's soul will bow before it in reverence. He will learn, too, one old but great lesson which may be applied in human affairs—"In union there is strength." The single ice crystal seems powerless; the many do mighty work.

If a mother is fond of chemistry, she has no less a field of work from the combustion of fuel and the burning of the evening lamp to the whole process of cooking, digesting, and assimilating food. Here, too, comes the question of the purity of air, water, and foods. A child may be taught to detect some impurities in all these, and also to test the safety of the colors in wall papers and in the fabrics used for clothing and furniture. These are but a few of the many topics close at hand for every mother fond of chemistry. Through all of this work in chemistry the mother has admirable opportunity to impress on the mind of the child the great economy of Nature. As the child sees the wax of the evening candle gradually disappear, he may be made to understand, by a few simple experiments, that some portion of the air is uniting with the wax; that invisible watery vapor and gas are produced and pass into the air; and that soot is given off. She is then prepared to believe Nature's great law—change, but no loss. The child, once impressed by this law, will find abundant illustrations of it, and will seek to know and understand the changes which produce the seeming losses so constantly occurring.

Perhaps some mother has a preference for astronomy. In warm evenings the little ones may sit out awhile to listen to stories about the stars. No subject is more delightful to a child. The little of the great truths which he can grasp will awaken and broaden his young mind and fill his tiny heart with noble and poetic sentiments.

Botany, zoölogy, and physiology will suggest fields of work as boundless as they are interesting. It is not necessary to suggest special lines of work in each; but let me urge that the intimate relations of everything studied to the life of man should be kept before the child, so as to cultivate that sympathetic interest which tends to produce gentleness and humanity toward all things. The song-bird rids his garden of insects, and the pretty wayside flower furnishes him medicine. By invisible but real bonds the life of man is united to the lowest animal and the smallest plant.

While it does not greatly matter where a mother begins, it does matter that, as she goes on, the child see relations clearly. Hence arrange the work in logical sequence, and branch off soon into other fields, that the little mind may have a natural, broad base on which to arrange its treasures of knowledge. All this,

too, must be varied according to the age and tastes of the child. Rightly presented, any one of the subjects named will soon win the respect, love, and enthusiasm of any child not hopelessly spoiled by too early dissipation in artificial social life. Such studies are one of the best correctives of this evil, and I have seen them cure some painful cases of it.

To a school where I was teaching there once came a child of nine, with manner and face plainly stamped with artificial life, and for weeks her teachers despaired of ever seeing any genuine, simple feeling. The child did not for a moment lose a painful self-consciousness which did not forget to air her charms at the entrance of a visitor, or when she wore a new article of apparel, as she frequently did. The first time she was asked to make a bill of materials which she might buy—materials of any kind—simply to show how bills are written, her bill began:

To one pink satin ball dress..... $80,
" one pair white kid boots..... $15,

and proceeded through eight or ten similar items of fancy and expensive dress. After our first vacation of one week this child returned with a glad, eager look on her face, and, going close to her teacher, said: "I am so glad school has begun again. There is nothing interesting going on at home." From that day her manner gradually changed; she came to love the stones, flowers, and animals which we studied, and her face lost its blank, soulless look and became sweet and gentle. This change in expression was so marked as to be spoken of by a frequent visitor.

Materials for study in any department of natural science are so abundant that it seems almost unnecessary to touch upon this topic. The greater abundance of botanical and zoölogical material in summer invites to those studies at that season, while physical and chemical studies may quite as well receive attention in winter; but with care and a small outlay in money any of these studies may be pursued at any season. A window garden, where a child may plant seeds at varying intervals and then pull them up and examine the whole plant at different stages of growth, is possible at any season; but this had better be done in early spring, when the vegetation starting out of doors increases the interest of the child and supplements his work.

The preservation of materials and the formation of collections are important. Encourage the child's efforts in this direction. Let the boys and girls make shelves, boxes, or cabinets in which to keep the collections. A set of wood-working tools and ability to use them will be a useful adjunct to natural-science study.

Whatever a child collects should be received with a smile of encouragement, no matter how worthless it is, until he has gained some power of discrimination. Let a mother refrain from show-

ing disgust or fear of any natural object—even of toads, spiders, and snakes—lest she foster in the child the common superstitions which attach harm to innocent creatures. And if the child brings a handful of frogs' eggs, sticky and dripping, the mother had better not say, "Now go away and throw those horrid, dirty things out; I will not have the house filled up with them"; and proceed to chide him for soiling his clothes and dripping water on the carpet. Let her show the child she is pleased with what he has done; get a jar in which to put the eggs, call the child's attention to the tiny dark spot in each egg, awaken his interest by telling him how the eggs were deposited and why they are fastened together in such a gelatinous mass, and that if he keeps them and gives them fresh water, a little animal may come out of each one. This will keep alive the spirit of investigation; and, after all this has been done, she may show the child how he might have kept from soiling his clothes and the carpet. A mother should never make fun of a child or laugh at his preferences, but try to enter into the child's thought and feeling, and, having done this, she may lead him to what she wishes. She should be patient, too; for, while the child's perceptions are often more keen and true than hers, he will find it hard to follow her reasoning processes and to see relations which are very simple to her. A mother should teach kindness by her own treatment of helpless creatures. Let her not crush the insect in the house, nor pull the weed from the garden with anger or impatience, but teach her child respect and kindness for all life until he has reached years when he can clearly distinguish between necessity and cruelty.

Be glad when questions are asked; hail them, if they grow naturally from the lessons, as the dawn of a good day for the child. Never say—as many a mother and, alas! many a teacher does in answer to a child's question—"Oh, that is too hard for you; you must wait until you are older." Is it surprising that children so treated lose courage and go through life thinking of every new difficulty, "Oh, that is too hard for me." There is a simple side to every subject; and if a child comprehend not a tenth of what is said, he is helped and satisfied by the effort to treat him as an intelligent being. If the child can not answer the mother's questions or his own, he should, if possible, be sent to Nature herself to find the answer, the mother giving only so much help as to direct his attention and insure his finding the answer within a reasonable time.

The child himself should handle the objects, manipulate the materials in experiments, make and record observations, and so learn to give accurate attention, and to keep exact accounts of what is seen, to use his own hands and eyes, to do. He who can do as well as think is twice armed against poverty or misfortune.

Accidents may be turned to account, not only to teach how
avoid them, but the immutability of Nature's laws. The soone
child finds that Nature never forgives a sin against her, the bet
for his health and happiness. I know one mother who has tau
her child to see the relation between headaches and candy; a
so well he understands it that now, at ten years of age, he d
not overindulge, although the favorite sweets stand always
the library-table within his reach.

Take advantage of any unusual phenomena. The last tran
of Venus was a chance offered not again in the lives of oursel
or our children, and every one might have seen it through
piece of smoked glass. A recent railroad-cut exposed fine
samples of ripple marks, which will soon be buried from sig
by falling earth. After some storms there are exceptional opp
tunities for lessons in physical geography and geology. Su
chances are of more value than many things for which we p
them sacrifice.

The relation of natural-science studies to health and to t
mental and moral culture of children has been suggested. The
industrial uses are familiar to all; so intimately are they connec
ed with the life of man that knowledge of any branch makes o
more capable in the conduct of his life. The relations betwe
these studies and the great workshops of the world may with a
vantage be pointed out until the child feels the mighty pulse
the world's work and acknowledges his debt of service and brothe
hood to all men. The habits of mind produced by continual co
tact with things, forces, phenomena, and laws promote clearne
of insight and ability to look over a wide field, and to gather t
facts necessary to form right conclusions. These are the habi
which give success in business.

Another important advantage in the study of the natur
sciences is found in their relation to invention. The emancip
tion of man from continuous manual toil is the prophecy whic
Science has already uttered; and she but waits the men to p
her forces at work in the right ways to fulfill this prophecy.
child rightly started has before him the possibility of doing so
of this needed work, and so adding to the sum of human know
edge and comfort. If he does not do this, he will have the unde
standing which will appreciate and encourage the labor of other
and if his pursuits early lead him quite away from the impet
to those studies which his mother may have given in childhoo
still her labors will be rewarded by the increased enjoymen
which touch with Nature adds to any life.

For mothers who have acquired little or no knowledge of na
ural science, it may be well to indicate some of the best sourc
of information and direction. For the most elementary work

Appletons' Science Primers and Ginn & Co.'s Guides to Science Teaching are among the best. For more advanced standard books, the works of Dana, Le Conte, and Geikie in geology, of Dana and Brush in mineralogy, of Gray and Bessey in botany, of Packard and Huxley in zoölogy, of Huxley and Martin in physiology, of Remsen in chemistry, of Meyer and Wright and of Ganot in physics, of Newcomb and Young in astronomy, are among the best.

Better than books are the collections of a well-arranged museum if they are by good fortune accessible. If possible, use them with the children, not for the amusement of an idle hour, but as teachers speaking more directly from Nature's heart than books can do. Also better than books is contact with a living teacher and association with others interested in the same work. Such help may be sought with assurance that one will seldom fail of kindly welcome and of all possible assistance. The Agassiz Associations, whose president is Mr. Harlan H. Ballard, whose headquarters are at Pittsfield, Mass., will furnish any mother with the opportunity of putting herself in contact with workers in this field, and of getting invaluable aid and inspiration.

Thus far in this paper the benefit of the study of natural science to the child only has been considered. But what of the mother? Truly, what increases the well-being of the child must increase hers also; but is there no personal gain to her apart from her child? Will it be nothing to be introduced to Nature, and to become a welcome guest where one has been a comparative stranger? Will it be nothing to leave the artificial and conventional, where so many masks are worn, and make friends with Nature, who cares nothing about dress, income, or pedigree?

Few mothers have not felt the renewal of youth which comes when in the woods, on the mountain, by the shore; have not found their cares slipping insensibly from them when gazing into the depths of the sky, listening to the murmur of a brook, or inhaling the sweet breath of the summer wind. Let me assure these mothers that every step in the study of any natural science will open more wide the door through which Nature will pour such healing balm.

O mother, tired with housekeeping, give your family simple, uncooked fruit for dessert; let puddings and pies go unmade, and give the time so saved to the pursuit of enduring pleasures; finish the little dress with a few less ruffles, and fashion for your child's mind a garment which can not fade or grow old; make fewer calls on your fashionable friends and more to the wood-lot, the open meadow, and the running brook; lay aside the latest novel, and go

> "Read what is still unread
> In the manuscripts of God";

do not stop to gossip about the newest scandal, your neighbor's new bonnet, or forthcoming party, but pause and bend your ear in the quiet places where the secrets of all life are told.

You have many hindrances in fashion and conventionalities. Do you wish you could stop and live differently—live more simply; wish you could offer family and guest alike simple bread, vegetables, and fruit without the fuss of the many courses and interminable combinations which consume time and often ruin the digestions and tempers of those who partake of them; wish you could get a few simple, artistic patterns for your own and your children's garments, and use them year after year without all this harassing discussion of what is style and fashion; wish you need go to no large parties, or ever give any, but let the few chosen friends come when they desire and take you and your home life as they find them? Do you wish all these? Then prove the desire by making them all true. But you answer, "I can not unless everybody else does." 'Tis the old story of "foxes and tails." We actually follow the maxim, "your conscience, not mine"; and forever is asked not, Is it right? but What will they think?

Why not make these radical changes? Every step of progress was once a difference which some brave spirit bore alone. Instead of fearing to be different, one may be proud and thankful to have found a better way to live: "The great world will come round to you."

COTTON-SPINNING SOUTH AND NORTH.

By HENRY V. MEIGS.

IN The Popular Science Monthly for January, 1890, appeared an article from the pen of Mr. Edward Atkinson, under the title The Future *Situs* of the Cotton Manufacture of the United States. In this essay Mr. Atkinson writes of what he understands to a remarkable degree, but I am confident that in some particulars there is a more favorable outlook for cotton manufacturing in the South than he is aware of.

First, as to the matter of sufficient humidity in the air, which, as he truly says, is so essential to success, especially in the manufacture of the finer numbers of yarn. An old gray-headed carder once told me that in his early experience in Scotland he was very much annoyed by the refusal of the drawing-frame slivers to fall into the eight, ten, and twelve inch cans supplied for their reception. This was before the invention of the pressing rollers, which force the slivers down where they should go. In his vexation one day, having a belt-awl in his hand, he raised his arm and plunged

the awl into the bottom of a thin steam-pipe which passed overhead. A jet of steam rushed out right down upon the refractory sliver, and, to his astonishment, down it went right into the can.

I have myself seen these same disobedient slivers fly all around a man's neck and shoulders and adhere there, to the great disgruntlement of foreman and hands. At the same old mill, above Columbus, the second if not the first mill built in the State of Georgia, the machinery was second-hand, brought from some Northern State. The spindles (fliers) were very ancient. Sometimes when they had a fair chance in fine weather they did pretty well, and at other times they would vex a saint. The very moment the sun sank behind the crest of the Alabama hills, however, there commenced an improvement in the action of these old spindles. Soon the room was in order; the boys and girls who attended the frames had a little time to "clean up," and their task was a light one for the rest of the evening. It seemed to me that the change was due to the humidity of the air inside, when the dampness of the falls right at the side of the mill was saved from evaporation by the withdrawal of the hot and drying sun-rays.

Mr. Atkinson writes wisely and well upon the subject of comparative humidity in different sections, and only *alludes* to means of artificial correction. Does it not seem probable that, with an efficient hygrometric testing apparatus, and with steam always at command capable of being admitted to a part or the whole of a department, the condition of the inside air, in this respect, may be kept almost uniform? The expense would be small, and the foreman, after being instructed, might be left to control the humidity of his room, as he is left to control its temperature. It appears to me that this consideration tends to make all manufacturing processes independent of climatic peculiarities.

Mr. Atkinson's remarks as to the coarser work of the Southern mills are all correct and go right to the root of the matter, but the inevitable changes to finer work have already commenced here, compelled, as they are at the North and East, by Southern as well as Northern competition. I was told years ago that a Northern manufacturer said that he could afford to pay ten thousand dollars per annum to get rid of the competition of one Southern mill on the same line of goods as those he was making.

Mr. Atkinson seems to have reached correct results, in his estimate of the comparative cost of raw cotton in Northern and Southern mills, but he does not allude to all the points that deserve consideration in respect to the ultimate cost of cotton *in the goods*. A Northern spinner recently mentioned his estimated waste at sixteen and three tenths per cent, but subsequently wrote me that he thought it was then about fourteen per cent. I think that Northern spinners usually estimate it at sixteen per cent. Even

fourteen per cent seems a very large wastage from "middlings," the grade my correspondent uses; which I attribute to his usin the Gulf and Southwest cottons—from Texas, Louisiana, Missi sippi, etc., made mostly by negro labor—in preference to cotto from the upper counties of this State (Georgia), made largely b white people—the farmers, their wives and children, who ce tainly handle the fleecy staple with far more care. The cotto marketed at Marietta, in Cobb County, about twenty-five mil above Atlanta, is generally beautifully white and clean. It is grow much more abundantly than before 1860, and almost always by th aid of fertilizers, which hasten the maturity of the cotton, so tha the crop of that part of the country is much sooner prepared fo market than in the lower counties, where it was often plowed i to make way for the new crop. The prejudice in favor of the Gu cotton has always seemed to me to be unfounded, though I kno it to prevail in Old as well as in New England, and generally i the North. These Northern spinners have often bought upland in New Orleans, shipped from Columbus and Macon in this Stat An old planter, who had also been a large cotton-buyer and manufacturer as well, always combated this idea. When the yar has fourteen to twenty turns of twist to the inch of length, it wi certainly fulfill all the necessary conditions as to twist, as well as the fibers were half as long again as they are. American spinner use a much higher grade of cotton for low numbers than th English spinners, to which I attribute the statement made to m by a Georgian of very high intelligence, who spent a number o years in China, and said that the Chinese greatly preferre American to English cloth, and I believe he said yarn also.

There is also, in my judgment, a very considerable advantag which the Southern spinner enjoys over his outside competitors; i that he receives his cotton in the loosely packed planter's pack age, measuring in depth twenty-eight to thirty-six inches, whil his competitors receive the same staple from the compresses, i which the bale is squeezed down to a thickness of eight or te inches under hundreds of tons of pressure. It *must* be brough into a flocculent state again before it can be carded and spu Does it not go without saying that the loosely packed cotton i the planter's bale will require less violent tearing to restore it lightness and elasticity than that which has been packed fo months under the compress with its enormous power? I hav seen myself, often, cotton "in the seed" brought to the mil weighed in two and four-horse wagons, without any baling at al ginned *in the mill*, and spun at once.

Now as to some other points. Suppose that I build two mil for myself (to insure the same management exactly). Let the be exact counterparts of each other, except that the machinery o

one is propelled by water at Augusta, and that of the other by steam north of the Potomac. Let both mills be required to produce the yarn from 4,000 bales of raw cotton, each weighing 480 pounds. The annual consumption will then be, in each mill, 1,920,000 pounds. With waste estimated at fourteen per cent, the quantity sent to the waste-pile will be from each mill 268,800 pounds, and each will yield the same amount of net yarn—viz., 1,657,200 pounds.

For my Augusta mill I buy a water-wheel or wheels of say 200 horse-power, and rent my power from the Augusta Canal Company. The rent charge is five and a half dollars per horse-power per annum; so that for 200 horse-power I will have to pay $1,100 for a year. My water-wheels will certainly cost less than a 200 horse-power engine, with its engine-room, boiler-house, stack, coal-bunkers, etc. But let us claim no advantage in first cost of power. I start my Augusta mill by simply giving a few turns to an eighteen-inch wheel on top of my gate-shaft, and it requires no attention until the rest-time arrives about noon, when the same number of turns in the opposite direction shuts off the water and all is at rest. At Columbus, Ga., at the Eagle and Phœnix Manufacturing Company's mill No. 1, our water-wheels of 112 horse-power each made eighty-four revolutions per minute. So you perceive I get a higher first speed from water-power than I would like to exact from a steam-engine of the same power.

In this section of country it is almost true to say that the motion of the water-wheel is never impeded by ice, as it is elsewhere. Water-power is not considered by some as being as steady a power as steam. I think this must be a superstition. The water-wheel has a continuous circular motion. The steam-engine changes rectilineal into circular motion at every revolution, and if with only one cylinder, at every half revolution. How can a revolution with one or two dead points be as continuous as a circular motion without any dead points?

Next I go to start my steam mill—exactly like the other except as to power. I must hire a costly engineer, for I can not trust my fine engine and my dangerous high-pressure boilers, with all the interests dependent upon their continuous action, to a Jack Leg. I must hire firemen and coal-handlers, for I would need three, four, or five tons of coal daily, and its handling is laborious and must be paid for. Then I must buy, let us say, three tons of coal per day at a minimum for three hundred and ten days—say nine hundred tons yearly. For my water-wheel a few tons or a few cords of wood will keep me and my hands comfortable and my machinery protected. Are these differences insignificant? Suppose both my mills last twenty years, and that they both run all the time. I have to buy in the twenty years eighteen thousand

tons of coal for one mill and a few cart-loads for the other. my engineer and firemen and coal-handling cost me in all $5 p day, I must pay out for this charge $1,550 per annum, and twenty years $31,000. So, for these two items, I have to pay twenty years $85,000 for one mill, while the other costs me for t same items *nothing*. It really seems as if "a masterly inactivity is the true policy when one considers the propriety of starti the cotton manufacture at the North with steam; but, on t contrary, a very masterly *activity* at Augusta, Ga., and at ma other points in this favored land of "Dixie."

Our mild climate and short winter enable the operatives make themselves comfortable at little expense for fuel and clot ing. They swarm to all new mills that are inaugurated, a think they are fortunate to find work. We have few strik here; hardly any in my experience of nearly fifty years. T relations between the employed and the employers are almo always of a kindly character. If we had twice as many mills work to-day in the South as we now have, employés could found to take every position except for a time some especial d partments of the work.

I have to buy 4,000 bales (1,920,000 pounds) of raw cotton f each of my mills. For the Augusta mill I pay probably fifte cents per bale to get it from the Augusta market to my mill on th canal—say $600 in all. For my other mill I have to pay a sma drayage here, and fifty-five cents per hundred pounds to get from Macon (if bought here) to, let us say, Philadelphia; 1,92 000 pounds, at fifty-five cents per hundred pounds, costing me f freight alone $10,560 against $600 for my Augusta mill. If th same prices and the same rates should continue, my twenty yea would net me an outlay for freights alone, without drayag $211,200 against my Augusta drayage of $12,000, leaving a ba ance of $199,200 against my Northern steam mill as compare with my Augusta water mill; and adding the power items above estimated, viz., $55,000 for twenty years, there has grow up a balance against steam of $254,200. It thus ap both mills should endure for twenty years, I w quarter of a million dollars more by sta wandering out in search of pastures n

The account seems to be
mill, but I am compelled
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Fourteen per
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and my waste goes to the waste-pile in Augusta. But I can not send my 560 bales of waste to Philadelphia so cheaply, but must pay the same rate as on raw cotton. My 560 bales weigh 268,800 pounds, and on this I pay fifty-five cents per hundred pounds to Philadelphia, or $1,478.40. Suppose this process to continue for a twenty years' life of the mill at the same rate of freight. At the end of twenty years I will have paid out to the Transportation Company $29,500 instead of $1,680 for my Augusta waste account.

I think, with Mr. Atkinson, that some very enthusiastic Southern spinners overrate the advantage the Southern spinner has in this respect. I doubt if it will average more than one half cent * per pound to the Northern than to the Southern spinner; and there are some very serious considerations, such as higher rates of interest, the absence of construction and repair shops, etc., which may considerably reduce any advantage we have now in cotton price. We are also at a greater distance from the large consuming markets, but the freight charge on the finished product is lower than on the raw material.

Last spring I was asked by a spinner what I thought would be the cost of changing half his spinning capacity from sixteen and twenty to number forty yarns. This is what must come in the not very distant future; and as the South advances to forty, the North must go to sixty, eighty, etc. The product of Southern mills can be made as perfect as that of any other section. Why not? The skill may be as great here as elsewhere, except for those branches of the work which are not yet attempted, but which will come in time.

Mr. Atkinson writes disparagingly of the longer working time in Southern than in Northern mills. He probably had not heard, when he penned his essay, that the Legislature of Georgia, at its last session, *fixed* the working t[i]me of cotton-mills at eleven hours per day. Many workin[g people] are clamoring for eight hours per day. I [think] too much for a day's work in a com[fortable] people who can not elsewhere find [comfort] and subsistence. I do not thi[nk] eight hours would, and my [wish] to give them in their [power] glad to embrace. The [bill], I believe, of ten hours' [labor] which my Augusta [mill] per cent more [than] pounds of yarn in

* Middlings in Macon at 10¼ [cents] —August 27th.

Georgia, while I make only ten pounds in Philadelphia. Is it not evident that to make my Philadelphia mill *equally efficient* with the other, it should have ten per cent more opening and carding power, more drawing, slubbing, roving, spinning, and finishing apparatus? Some people say that ten hours make as good an output as eleven; but don't they forget that the product depends upon the spindle revolutions at last? While the spindle revolves at normal speed, the twist must perforce go into the yarn.

A mill has just commenced operation here, in the outskirts of Macon, with English cards of fifty inches diameter and forty inches wire surface, with top flats instead of rollers. They turn off a little more than twenty pounds each per hour—two hundred pounds and more per day. The card-room machinery is of English make and functions admirably. The spinning machinery is of American make and is A No. 1. The product is very large, and the demand for it so great that I was informed recently that the mill was operated until 9 P. M. Most managers prefer American machinery. I do not, for the carding department. The American Robbeth spinning-frame seems to be almost beyond any further improvement. There is no objection to it, as far as I know, except that its cost is so great compared with the English cost of the same machine. I am told that these American spindles cost this Macon Company $3.30 each, while I have among my papers proposals for the same spindle in England at eight shillings (about $1.92 each). Most of the practical and skillful foremen are men of Northern training, and have very strong predilections for the machines they have been accustomed to, and many of them are only operators of mills, not constructors or owners. One gentleman said in my hearing some years ago, "No man can make money in this country with English machinery." I reminded him (it was in 1880) that the English had built forty millions of spindles for their own mills, and probably as many more for the rest of the world, while the United States had then only about ten millions; that some of the brightest intellects of England had been engaged for more than a hundred years in the invention, the construction, the operation, and the improvement of cotton-working machinery, and that they might be supposed to have reached results at least comparable with American results. He said no more.

Is it not ridiculous that people of sense say, after so long "protection," that they can not compete in price with English machinists—especially now, when I see the statement made that American iron can be sold in England from five to six dollars per ton cheaper than the English can make it at home? The manufacturers of the North and East generally seem to be unable to conquer their prejudices in which they have been indoctrinated

from their youth up. How forcibly Daniel Webster appealed to them to conquer their *prejudices!*

I have been informed that some people at the North anticipate a scarcity of operatives for newly inaugurated mills in the South, but the idea is new to me. In truth, so highly do I estimate the desirableness of this occupation, especially to the women and girls of these Southern States, that it has always appeared to me that this class of persons, if they understood the matter, would "cry aloud" for the repeal of the duty on imported cotton machinery; not on goods to be made in such mills, but on the machinery with which to make the goods. This duty is thirty-five per cent on the cost of the iron and forty-five per cent on the cost of the steel used in machine construction. Why should our machinists have this great prop to their business, while farmers, miners, and other workers indirectly pay the duties thus imposed? The farmers of the West pay under our system $345,000,000 annually, without any good to anybody. I quote from a remarkable treatise I read some years ago, by Alfred Mongredien, an English writer: "But this is called 'protection!' Phœbus! what a name! Protection for the very few American machine-builders, but destitution for hundreds of thousands of poor women and children who long for work but can not obtain it because the machinists are so much 'protected' that would-be mill projectors can not afford the high prices demanded for machines."

Just think of sulphate of quinine! A few years ago it was sold at six dollars per ounce at wholesale. The duty was repealed, and I understand that it can be bought now at some forty-five cents per ounce. Six dollars under protection; forty-five cents with competition open to the world. So with cotton-machinery: $1.92 per spindle in England, $3.30 per spindle at home!*

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* As I conclude this paper I am handed the inclosed slip, right to the point:

"CAN NOT STAND SOUTHERN COMPETITION.—Baltimore, March 29th. The cotton manufacturers of Baltimore are alarmed at the progress of the South in that branch of the national industry. One of them said to-day: 'We never cared for New England competition; it never cost us a thought. We sold, and still sell, more goods in Boston than we do in Baltimore. But it is the South that is hurting us. Since the opening of the cotton-mills in Atlanta, Ga., and other places in the South, our trade has fallen off twenty-five per cent. It is a mistake to suppose that those cotton-mills are hurting the New England mills. It is Baltimore that is suffering from their competition. They have the advantage of being right at the cotton-fields; they have unlimited water-power, and they have labor as cheap as and even cheaper than we can have it here. The children they employ work seventy-two hours a week, while the law here allows children to work only sixty hours a week. Of that, however, we do not complain, as we would not care to have the children work more than sixty hours.'

"The amount invested in cotton manufacture here is about $5,250,000, and the annual product of the mills amounts to $7,250,000. Over 5,000 hands are employed, who receive annually about $1,600,000 in wages. The cotton manufacturers of Baltimore held a meeting last night to discuss the situation."

INVISIBLE ASSAILANTS OF HEALTH.

By SAMUEL HART, M.D.

IN the natural competitive strife for existence among all organic beings, man had formerly recognized the fact that he was in direct antagonism with opponents which were formidable in proportion to their size, strength, and ferocity; and against whose aggressions he was to measure *force*, guided by his best intelligence. It has been, of course, a matter of common observation from most primitive times that some mysterious, invisible influence was constantly at war upon human life, but whose nature and intent were believed to be beyond permissible human ken. Scarcely a ray of light seems to have been shed upon this occult cause of human destruction until the present century; indeed, until within the last score of years. It is true, microscopy had been gradually unveiling to our astonished vision a new world, teeming with life of incalculable activity and scientific importance. But only recently have improved instruments and methods transformed a former invisible field into a true vivarium of beings, each having its distinctive size, color, form, requirement for food and place, with its cycle of birth, life, and death peculiar to its species.

It is now understood that our material world, with its visible occupants, is supplemented by and interdependent with myriads of micro-organisms, permeating or enveloping all matter, and whose relation to organic life is essentially cosmical. In some of their multifarious forms they are the direct and only means and medium of transformation of material from its cruder form into the appropriate food for all organic beings; apparently having the power of wresting atom from atom in the mineral world in order to render it available for themselves as well as for plants and animals; thus performing a work purely beneficent and essential. Other forms of minute organisms are employed in the mutations of nature in undoing the work of the former; and, as if endowed with a spirit of maleficence, are occupied solely with the work of decomposing all organic substances, inducing decay and death.

These bodies are of the so-called low forms of life; impelled by natural necessities to provide for themselves where and as best they may. They are of independent vitality, each individual having its definite organization and requirement as to kind of food, temperature, and amount of light and air. They belong to distinct species, and are reproduced in kind, with as much exactitude in size and form as are the large plants and animals, both of which natural divisions they represent.

They increase with such amazing rapidity that, unless limited by want of nutriment and favorable environment, a single species would in a few years occupy the earth's surface to the exclusion of all other life.

Many species are of wonderful vitality and tenacity of life, and resist the extremes of temperature, of boiling and freezing. Others may be dried to an entire suspension of vitality for months and years; wafted here and there by the winds until, under favoring circumstances, they renew their wonted activity. Scattered on the snow of the hill-side, and carried down with the spring freshet, miles away, they may be swallowed with the water by some unfortunate individual, and perhaps prove their presence and their source by inducing in him an infectious disease of their specific kind.

The microbes may be captured, and cultivated on beds of gelatin, albumen, sugar, and in broth of meats; and under skillful management be made to furnish flourishing colonies and specimens of the highest degree of development. Or they may be starved and chilled to such helpless weakness and attenuation as to seem to lose their specific characteristics. Those we are considering are among the most minute bodies within the possible scope of microscopy. This, and their perfect transparency, have heretofore seemed an insurmountable hindrance to our further knowledge of them. But the discovery of their strong affinity for certain of the intense coloring matters has been fortunate and timely, furnishing a key to brilliant developments, since it is found that certain species show a predilection for special colors; and a particular part of the microbe, as its membrane, or its contents, may unite with the color, while other parts may totally reject it—thus giving, not only outlines, but illuminated internal structure, otherwise invisible and unknown.

The extreme minuteness, then, of these bodies has heretofore been the bar and hindrance to our better knowledge of them. But already we have been able to peer downward and inward, from gross visible matter, through organs, tissues, cells, nuclei, nucleoli, and granules, until, in the so-called *structureless protoplasm*, our present hunting-ground and limit, we seem to have reached the confines of the inorganic molecule and atom, which are subject to chemical instead of physiological law. The modern discoveries in this microcosmic realm, and the demonstration of the causative relation of micro-organisms to disease, upon which the "germ theory of disease" depends, stands so conspicuously as a scientific success, and is a step so important toward the alleviation of suffering, the prolongation of life, and enhancement of human happiness as to be the subject of universal congratulation.

In order to comprehend the importance of this subject, it must

be assumed that each of the long list of diseases known as *infe* fevers is caused by its own specific *virus*, and that no other ma terial or combination of agencies can produce it. This fact is universally recognized. Furthermore, it has been demonstrate in a large proportion of these diseases that the essential princip of infection in the virus is the *living germ* called the pathogen microbe.

The literally *vital* relation of microbic to human life can b observed in the following general statement: The pathogenic m crobes cause four fifths of all diseases of the human family; the destroy more lives than war, famine, fire, murders, shipwrec and all other casualties; and they actually abbreviate the ave age natural term of human life by three fourths, and constantl depress the health average of the world's population far below it natural standard.

They are an insidious but powerful and relentless enemy t human kind, holding sway over a large part of the most beauti ful and fertile portions of the earth, excluding man at the peril o his life; while, as if with malicious discrimination, ferociou animals and venomous reptiles find there their congenial hom and vegetation reaches its acme of luxuriance. Like some dia bolical spirit, in the form of the epidemic, it leaves its nativ habitat, and with insatiate malignity, sometimes with slow bu irresistible progress, and again by rapid flight, passes all barrier of mountain, sea, and distance in its pursuit of man, its onl known object, and whose destruction is its only visible effec This is shown in Asiatic cholera, the plague, yellow fever, and th lesser scourges. The strife for possession in some coveted regio has been progressing for ages. Man may advance his outpos under the favoring light of sunshine, but must retreat, or fortif himself against the dangerous shades of night, until, by slow de grees, advantages are gained over the invisible enemy.

The Italian Pontine marshes, the jungles of India, the bank and shores of the tropics, our own Southern lowlands and fertil new prairies are the strongholds of *Bacillus malariæ*.

"The pestilence that walketh in darkness, and the sickne that wasteth at noonday," are known to be the work of the armi of the microbes.

Some of the means and methods of the micrologist, in his re searches, must be mentioned. His outfit is extensive and nove It includes the best known microscopes and a well-constructe incubator with heater and thermometer, numerous test-glasse beakers, filters, acids, alkalies, deep-colored dyes, and a good sup ply of prepared cotton.

In studying the life history of his microbes he will require well-supplied commissariat. He must be a professional catere

and a bountiful feeder. He must have fluids, semi-fluids, and solids, broths of various meats, peptonized food, the serum of blood, *à la Koch*, and Pasteur's favorite recipe with the French refinement: Recipe, 100 parts distilled water, 10 parts pure cane sugar, 1 part tartrate of ammonium, and the *ash* of 1 part of yeast. Among the substantials must be found, boiled white of egg, starch, gelatin, Japan isinglass, and potato—the last, from South as well as North America.

The appointments of his *cuisine*, and the extreme care and delicacy of manipulation required, will be shown in the preparation of a broth for the cultivation of a particular species of microbe. First, let it be remembered, all our surroundings are swarming with micro-organisms, a thousand times more numerous than the locusts of Egypt, and to exclude them from the kneading-troughs of the micrologist requires all the knowledge of the last quarter of the nineteenth century. A matter of the first importance, then, is that everything connected with the cultivation of microbes must be *sterilized;* which means that every microbe not wanted for observation must be destroyed; and no exorcism except by fire or the strongest antiseptics is found available. The preparation of a nutrient material for the cultivation of selected germs, according to Klein, will illustrate:

Place in a glass beaker fresh meat and water, equal weights; boil one hour; strain through a sterilized filter; after allowing the *bouillon* to stand for five hours, boil and filter as before. When cool, place in preserving glasses which have been sterilized by the flame of gas or the hot oven; then close by sterilized cotton, and boil again for *over thirty* minutes, and cover the mouth of the glass with an inverted beaker, one half filled with sterilized cotton, in order to effectually exclude the germ-laden air. Boil again the next day, and, when cool, place in an incubator for twenty-four hours at a suitable warmth, in order to hatch into life some possible germ of salamander endurance; and, finally, boil again for more than thirty minutes, in order to destroy this last suspected germ. If everything has been skillfully done, we have now a culture fluid exactly suited to the growth and development of a certain kind of germ only. These numerous steps and precautions for food-making may appear useless and absurd, but a little haste or a false step would undo the work of many days, and only this extraordinary attention to every detail has, after years of investigation, attended with acrimonious discussion among scientists, finally and forever settled the question of "spontaneous generation," as if in reassertion of the law that every living thing shall bring forth after its kind.

The method of demonstrating the germ cause of disease is as follows: Using only sterilized test-tubes, forceps, pipettes, cotton,

etc., take a particle of virus, known or supposed to contain pathogenic microbes, from a person suffering from an infectious disease, insert it by a delicate glass pipette through the sterilized cotton plug of a test-tube containing some of the prepared culture material, and deposit it there. Then place the tube in an incubator, warmed to the required degree, and let it remain for the number of hours suited to the peculiar requirement of its germ contents. By this means a vigorous progeny of one kind of microbe is obtained, while the tendency is to eliminate other kinds whose requirements are different.

But to further insure the exclusion of the ubiquitous horde, take out carefully a little colony of the vigorous microbes of the first culture through the cotton covering and place it in a new culture-tube with the same precautions as before, and so on, until, through high feeding of our test microbes and the adverse treatment of the others, we have, by microscopic tests, the thoroughbred, vigorous, and, may be, deadly microbe, which may be seen and every characteristic noted as to size, form, coloring, manner and time of development, all of which enable the observer to fix its classification. But the crucial test as to the relationship of a certain species of microbe to a particular disease is made as follows: Take, as above, the microbes from an individual suffering from a well-known infectious disease, cultivate them to complete isolation and perfection, and introduce them by inoculation into the blood or tissues of a healthy person. Here they must undergo a period of development or incubation, requiring just the number of days and hours as in the culture-tube. This fully developed disease must be strictly the same as that which furnished the test germs.

In making these experiments with the virus of dangerous diseases the human subject can not, of course, be deliberately employed; but casual inoculations and infections furnish opportunities for exact observation. A few enthusiastic pathologists and would-be martyrs have submitted to inoculations which have proved of scientific value. The inferior animals furnish much valuable material in this line, although they are entirely exempt from many diseases belonging to man; while in the human subject there seems a greater general susceptibility to microbic infection.

Founded upon the knowledge of the natural history of the pathogenic microbes has come the only scientific and satisfactory classification of the infectious diseases. It may be stated, as a rule, that the virus of infectious diseases originates either in the bodies of diseased living beings or in decomposing organic matter. When *the germs of the virus mature in the living being*, ready for reproduction in another person, they produce the *acute*

contagious diseases, including small-pox, chicken-pox, scarlet fever, typhus fever, relapsing fever, measles, miliary fever, influenza, whooping-cough, and hydrophobia.

In another class, called *miasmatic contagions,* the germs are propagated in diseased persons, *but, as a law of their further development,* they must undergo one stage of change outside of the body, in some decomposing organic matter, before they can again produce their peculiar disease in a healthy person, except by inoculation. To these *miasmatic contagious* diseases belong typhoid fever, yellow fever, cholera, diphtheria, acute consumption, cerebro-spinal meningitis, and erysipelas. When the virus *originates* entirely in decomposing vegetable matter, we have the *malarious* diseases: intermittent fever, remittent fever, continued malarial fever, pernicious fever, dengue fever, and chronic malarial infection.

Adopting this classification gives practical advantages without waiting for the demonstration of the particular microbes of each disease or their *modus operandi.* It is sufficient practically to know that the whole list of infectious diseases is accounted for under well-known laws of microbic generation. Indeed, the pathogenic cause may simply be called a *virus;* reserving only a distinctive character for each of the classes mentioned, viz.:

1. A virus which reaches full development in the diseased person, ready for infection in another, as in the small-pox class.

2. A virus which must be produced in the diseased person, but is not transmissible to another until after undergoing further development outside of the body; and usually in some decomposing organic matter. This is true of the typhoid-fever class.

3. Where the virus originates invariably in decomposing organic matter, and, after infecting the human subject, is never transmissible directly from one individual to another. This is the malarial class, including all the intermittent fevers, or the agues of slight degree as well as dangerous remittents and pernicious fevers, the intermittent neuralgias, and the "dumb agues."

Numerous other and very extensively prevalent diseases are known to be of microbic origin; among them pneumonia, rheumatism, tetanus, rabies, and the venereal in its numerous forms and phases.

Aside from the advantage of a scientific classification of diseases is that gained in the matter of prevention as well as cure; in both of which much has already been realized.

The means and manner of action of microbes in their destruction of life and health are various, and in some instances, as yet, obscure. As a prerequisite to their infectious development they must gain access to the blood or tissues through the cutaneous exterior or the mucous interior of the body; each species having

its peculiar site for ingress, its locality for operation, and its peculiar way of accomplishing the destructive work. Some produce harmful if not fatal changes in the blood by appropriating some of its vital qualities, leaving the system robbed and impoverished. Others seem to obstruct the minute vessels by their immense numbers, and thus do harm in a mechanical way. Some attack the blood-cells, penetrate their walls, and absorb their contents. Another and most important action of microbes is the production of poisons of deadly intensity, tending not only to the destruction of the infected person, but of themselves as well.

These products of the pathogenic germs, called *ptomaines*, seem to be the means of the suicidal limitation of germ-life in certain instances—where, having gained access to the healthy tissues, they flourish for a time, destroying as they go; but presently they lose their vitality, poisoned by their own venom, which may be sufficient in quantity and intensity to destroy the individual infected. This fortunate tendency to self-destruction of microbic life seems to belong to the infectious diseases.

A remarkable and important fact here is the exemption acquired by the individual once having a disease from all future attacks. The explanation is as yet difficult. By some pathologists it is supposed that the change in the system is due to the permanent retention of a sufficient amount of the ptomaines generated by the first microbic invasion to prevent a reintroduction of the same species. In that case the ptomaine would prove no hindrance to the successful attack of other species. Some suppose that an essential nutritive principle in the system becomes completely consumed by the first attack, and may never be reproduced to support a second one. But recent observations on the behavior of certain *cells* furnish a means, at once the most plausible and remarkable, for explaining the acquired disease-immunity, as well as a variable degree of original protection. These cells, called leucocytes and phagocytes, seem possessed of an instinctive, independent existence and behavior, suggestive of intellection. They are capable of locomotion, and a change of size and form—being constructed of elastic cell-walls of most filmy attenuation.

Their purpose, in part at least, seems to be to protect the system from harm within the blood, organs, and tissues. They are found where they may render the most ready and efficient service, particularly in the blood and in the air-cells and bronchioles of the lungs. Like a light guard in peaceful times, they are not conspicuously numerous; but in time of an attack they present themselves in great numbers and efficiency, and their energy in defense seems increased by any opposition not quite overwhelming.

The means of aggression or defense, as well as of sustenance, of the phagocyte, is by attaching itself to a particle of matter, and gradually surrounding and incasing it in its membranous walls until it is literally swallowed. If the particle should be a microbe, rich in protoplasm, it would be digested by the voracious and omnivorous *phagocyte;* but if of mineral origin, as dust of coal or sand inhaled by the lungs, it would be carried to the surface or to a safe receptacle, where the cell, having performed its mission, deposits itself, still incasing its burden. The phagocytes seem to meet whole broods of infective microbes which *may have* invaded the body, and destroy them, and, as it were, gradually acquire and permanently retain such efficiency as in future invasions of the same species to prevent any harmful action. The contest between these opposing forces does not always terminate with regularity as to time, as in the acute infectious diseases, but may become chronic, and the time and result uncertain.

In the slow, malarial diseases, according to this theory, the phagocytes finally acquire a domination more or less complete over the *Bacilli malariæ*; and this occurs not because the malaria has become less virulent, but because the phagocytes have acquired unwonted potency during the contest. This *acquired* domination of the phagocytes over one species of microbe seems not to be available against the inroads of other species. The exemption acquired in diphtheria and some other diseases seems partial as to degree and uncertain as to time.

One dreadful example of the failure of self-limitation of disease is found in hydrophobia. Here there is no natural stay or check to its fatality, and, although the most distinguished pathologists have given this question their best attention for many years, it seems questionable whether any life has ever been saved from hydrophobia. Large numbers of persons have been treated by inoculation for *supposed* hydrophobia, many of whom died, and the symptoms proved the hydrophobic cause; while in those who recovered no positive demonstration of true hydrophobia could be made, and the question of curability or prevention by inoculation remains undetermined.

M. Pasteur, the wizard micrologist, claims success in his battles with the rabies germs, and his brilliant achievements in other fields lend encouragement to expectant humanity. Jenner's vaccine discovery, by which millions of lives have been saved, encourages the sanguine belief that the principle of inoculation will, ere long, be made available for the preservation of countless human lives.

The method of M. Pasteur has been to obtain some of the positively fatal virus from the brain of a person or animal which

had died from hydrophobia, and to reduce the germs through numerous generations by a system of modifying treatment until they have lost, in some degree, their fatal virulence, while at the same time they may have retained a protective activity within the limits of safety.

In the warfare with the pathogenic microbes the idea of employing certain species as our allies, and opposing them against the very dangerous ones, is brilliant, and there are many facts encouraging the belief that the kingdom of the microbes may be further divided against itself, through the natural voracity of its numerous clans. Surely any tactics and every means, agressive and defensive, must be made available against an enemy so insidious and so formidable.

THE EVOLUTION OF CHEMICAL TRUTH.

By M. LOUIS OLIVIER.

IN his Lectures on Chemical Philosophy, J. B. Dumas has taken notice of the "singular contrast which is to be remarked among ancient peoples between the flourishing condition of industrial chemistry and the entire absence of theoretical chemistry." Empiricism, commanded by the necessities of material life, had, in fact, to precede the disinterested speculations of the reasoning powers. In this way the Phœnicians and Egyptians made discoveries of great significance in the arts of metallurgy, glass-working, and dyeing, without being guided by any scientific light. They interpreted them in a mystical sense, conformable to their religious conceptions of nature. Whatever we may think of their theories, we can not forget the positive bases of them; for the rational science of our century has been derived from their observations, winnowed by the ages. The facts have resisted the assaults of time, while the magic, the theurgic doctrines, found to be sterile, have gradually disappeared to give place at last to the fruitful idea of natural laws. It was a curious metamorphosis, in which astrology, alchemy, and the old medicine predicating the virtues of stones and talismans, mark the transition from the ancient to the modern mind.

It is with great interest that we follow with M. Berthelot * the evolution that has thus taken place in chemistry from the ancient Orientals to the Greeks, and from them to us; for it is associated with the development of philosophical ideas, consequently with the history of the human mind. From the time when alchemy

* Les Origines de l'Alchimie (Origins of Alchemy).

in a somewhat sudden fashion made its appearance in the world, till the moment of the fall of the Roman Empire, we know very nearly what it was, but are hardly certain whence it came. The study of which we are about to give an account assigns for it a triple origin: the industrial processes of the ancient Egyptians, the speculative theories of the Greek philosophers, and the mystic reveries of the Alexandrines and Gnostics. This conclusion is derived from the attentive examination of documents that have not been studied before with this point in view; among which are Lepsius's memoir on the metals in antiquity, Egyptian papyruses in Paris and Leyden, and Greek manuscripts in the French National Library and St. Mark's Library in Venice. M. Berthelot has compared with these texts, on one side, the beliefs of the first alchemists concerning the origin of their art; and, on the other, their positive knowledge, as well as the theories accepted in the second and third centuries of the Christian era. The deductions from these different sources are quite concordant.

Zosimus the Panopolitan, "the oldest of authentic chemists," wrote, three hundred years after Christ, that "the Scriptures teach that there is a certain race of demons that have commerce with women. Hermes has spoken of them in his book on nature. The ancient and holy Scriptures relate that certain angels, smitten with love for women, came down upon the earth and taught them the works of nature; on this account, they were driven from heaven and condemned to perpetual exile. From this intercourse sprang the race of giants. The book in which they taught the arts is called *Chema*, whence the name *Chema*, which is applied to the most excellent art." This idea of sinning angels who revealed the occult arts and sciences to mortals, is found in several countries. It is "in harmony with the old biblical myth of the tree of knowledge placed in the garden, the fruit of which when eaten brought about the fall of man."

The Theban papyruses at Leipsic attribute the same mystical character—a kind of seal of its Eastern origin—to alchemy. It was Hermes Trismegistes who made known practical metallurgical processes, the *hermetic science*, the mysterious art of transmutation. The Egyptian priests, who were instructed in it, had to take an oath to keep the secret of it. This custom was preserved among the Neoplatonists and magicians of the fourth century, and the alchemists of the middle ages and the Renaissance.

Many of the traditions held in honor among the alchemists seem to have been borrowed from the Theban priests. The number four was sacred with both. The philosopher's stone was called the Egyptian stone in the middle ages. The alchemic sign for water was the hieroglyph for that substance. The sign for tin, which has been transferred to the metal mercury, was also

the hieroglyph for the planet Mercury; a
observable between the sign for gold and
sun. Osiris was the synonym for lead, sul

This mystic relationship of the metal
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mentioned the relation between gold and t
his commentary on the Timæus, wrote, "
the moon silver, Saturn lead, and Mars iro

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This confluence of the Chaldo-Egyptian
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Hermes, John, Arch-priest of Thutia, an
brated philosopher of Abdera. But the

Zosimus, the experimenter, the historian and biographer of Plato, Olympiadorus, and Stephanus, authors of important memoirs on the art of making gold. For that purpose they employed, according to the manuscripts, a projecting powder endowed with the mysterious power of impregnating bodies. This powder was prepared in the Thebaid, at places which, according to Agatharcides, were centers of metallurgical enterprises.

In the ninth century all the documents are found in the hands of the Arabs, who became the depositories and continuers of Grecian science. Mussulman civilization has handed down to us the history of the mythic alchemists, their mysterious formulas, and the practices which they adopted for blanching and yellowing metals—that is, for changing them into silver and gold. In their conceptions of matter, the Arabs of Spain and Syria followed in part the philosophical systems of pagan Greece; and their authors freely quoted Aristotle, Heraclitus, Xenocrates, Diogenes, and Democritus. The story of their doctrines and brilliant discoveries is told in all histories of chemistry.

M. Berthelot's detailed review of the positive facts which alchemy received from antiquity makes it manifest that Egypt left an inestimable treasure to the world. The priests of Thebes and Memphis made great advances in the knowledge of the art of extracting metals, of forming alloys, and of making vessels and tools out of them. They distinguished crude gold from refined gold, and could work that metal up into a variety of articles. They fed the hope that they might be able to obtain it by coloring *asemon*, or silver, yellow. Of the latter metal they made money, the value of which was guaranteed by an impressed image. They extracted gold and silver from *electrum*, a mineral containing both substances, but which presented to their eyes the appearance of a metal like them. This was what led them to the notion of transmutation.

The Egyptians designated as *chesbet* several kinds of blue or green sapphires colored with cobalt or copper. They made incrustations, amulets, necklaces, and various ornaments of them. They succeeded in compounding an artificial chesbet resembling the natural stone. A fact worthy of remark in the matter is, that this was done by "the assimilation of a colored substance, a precious stone, an enamel, a vitrified color, with metals." This assimilation suggested the new idea of dyeing; "for the imitation of the sapphire rests on the coloring of a large mass, colorless by itself, but constituting the vitrifiable basis, which we dye by the aid of a small quantity of coloring matter. With enamels and colored glasses thus prepared, the natural precious stones were reproduced; they were covered with figures, with objects of earth or stone, and were incrusted with metallic objects."

Among the minerals and metals known to the Egyptians are also mentioned the emerald, malachite, copper in alloys, iron, lead, tin, and mercury, the mobility of which caused it to be regarded as living; whence the name quicksilver. Their tinctorial art included dyeing in yellow, white, and black; and they could also dye purple by means of alkanet and archil. All these changes brought about in the appearance of bodies seemed to be modifications of their properties, and consequently to legitimize the expectation of effecting transmutation. We should, however, recollect that the idea of the fixedness of the properties of bodies is wholly modern. Even Bacon wrote in the seventeenth century: "Observing all the qualities of gold, we find that it is yellow, very heavy, of a certain specific gravity, malleable, and ductile to a certain degree; and whoever is acquainted with the formulas and processes necessary to produce at will the yellow color, the high specific gravity, the ductility, and knows, also, the means of producing these qualities in different degrees, will perceive the means and be able to take the measures necessary to unite these qualities into a definite body; and from this will result its transmutation into gold." This was, in fact, the dream and the mastering passion of the alchemy of the middle ages and the Renaissance.

These conceptions were very ancient, and must be looked for in their original forms in the Greek philosophy. The germ of the doctrine of transmutation is in the Timæus. It rests on the idea of primitive matter, the indifferent supporter of all the qualities that can be heaped upon it. Plato insists upon the idea, which he regards as fundamental, that "the thing which receives all bodies never comes out from its own substance. It is the common basis of all the different substances, and is deprived of all the forms which it would receive otherwise." The primary matter was supposed to be composed of fire, which made it visible, earth, which made it tangible, air, and water, which assured the union of the earth and the fire—these four elements being formed of minute corpuscles, susceptible of changing into one another; for we see, says Plato, "that water, in condensing, becomes stone and earth, and in melting and dividing itself up, becomes wind and air. Air inflamed becomes fire; fire, condensed and extinguished, resumes the form of air; air, thickening, changes into mist, and then flows as water; and from water are formed earth and stones."

All bodies were believed to be the seat of a transformation of this kind. Under the influence of this thought, Proclus wrote, "Things being never able to preserve a nature of their own, who shall dare affirm that one of them is this rather than the other?" It is, therefore, by virtue of a necessary law of nature that bodies

are modified, and transformation is possible. This determinist conception was afterward mingled in the minds of the alchemists with Oriental mysticism; but it must be remarked that it presented, in the Greek philosophers Thales, Anaximenes, Heraclitus, Empedocles, Plato, and their immediate heirs, a really scientific character. Michael Psellus was faithful to their doctrine when he wrote to the Patriarch Xiphilin, in a letter which was used as the Preface to the Collection of the Greek Alchemists: "The changes of nature are made naturally, not by virtue of an incantation or a miracle, or of a secret formula. There is an art of transmutation. . . . You want me to teach you the art that resides in fire and furnaces, and which produces the destruction of substances and the transmutation of their natures. Some believe that this is a secret knowledge, gained by initiation, which they have not tried to reduce to a rational form; which seems to me an enormous error. For myself, I try first to learn the causes, and to deduce from them a rational explanation of the facts. I sought it in the nature of the four elements, from which everything comes by combination, and to which everything returns by solution."

From Greece alchemy then received, with the idea of a primary matter and the system of atoms, a whole contingent of rationalistic notions which subsequently modified more or less Christian mysticism and the traditions of the East. The effort of the alchemists of the middle ages to divest the metals of their individual qualities in order to reach the primitive matter, the mercury of the old philosophers, was then in harmony with Plato's metaphysics. But, in the operations they performed for that end, they could only determine the indefinite transformation of the elements, and they represented the mysterious process under the symbolical form of a ring-serpent which has neither beginning nor end. This hopeless picture of chemistry did not cease to be true till the end of the last century. By introducing the balance into laboratories, Lavoisier demonstrated that the weight of metals is invariable, and, in a general way, that the origin of all chemical phenomena lies in the reactions of a small number of undecomposable bodies, the weight and properties of which are constant.

This great discovery sapped the alchemic doctrine of the transmutation at its very foundations. It is, however, still permissible to ask if the present elements, as yet undecomposed, are really simple bodies. If Prout's hypothesis that they are polymers of hydrogen could be demonstrated, the hope of passing from one to the other would be entirely legitimate. But the recently carefully made determinations of the equivalents of simple bodies by Dumas and Stas have weakened that theory. The laws of specific

heat, moreover, do not permit us to see in our present simple bodies polymers of the same substance comparable to known polymers. The specific heat of the last increases, according to Woestyn's law, with the complex structure of their molecule, while the specific heat of simple bodies varies, according to Dulong and Petit's law, inversely as their equivalents.

We may, nevertheless, conceive the unity of matter in another sense. Some chemists oppose to Prout's hypothesis a new and more comprehensive one, which consists in regarding the elements as states of stable equilibrium in which matter exhibits itself. "In this order of thought," says M. Berthelot, "a body reputed simple could be destroyed but not decomposed in the ordinary sense. At the moment of destruction it would at once transform itself into one or several other simple bodies, identical with or resembling the existing elements. But the atomic weights of the new elements could not offer any commensurable relation with the atomic weight of the primary body from which they are produced by metamorphosis. More than this: by working under different conditions we might see appear sometimes one system, sometimes another, of simple bodies, developed by the transformation of another element. Only the absolute weight would remain invariable in the course of the transmutations."

Even under this hypothesis the hope of forming simple bodies need not seem chimerical. Unfortunately, we have no more reasons for encouraging it than for condemning it. All that can be said respecting it is that the present condition of science does not allow us to discern any method that will lead to the end. Would it not be wiser, then, to make our theories more complete rather than venture into this darkness without a guiding thread? It is no mystery to any one that they greatly need improvement. The imponderable fluids have only just passed away; the ether, too, seems to be already withdrawing, taking along with it, perhaps, the atom of the chemists; and does it not seem that everything is about to be explained by motion?

M. Berthelot discusses these questions with his well-known vigor and originality. His work, erudite and pointed, is particularly instructive to the thinker. He in fact restores to our view the affiliation of the systems that were conceived at the birth of chemistry, and which have been revived at our time in the effort to resolve the eternal problem of the constitution of matter.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

IRRIGATION IN CHINA.*

By GENERAL TCHENG KI TONG.

I PURPOSE to describe what has been accomplished in utilizing the natural waters in our country, where for four thousand years we have sought to get all we could out of them. By means of economical utilization our lands, notwithstanding the extraordinary multiplication of our people, have furnished us ample supplies of food. One of our proverbs says, "Always have children; Providence, which brings them to light, will not let them die of hunger." You never see insects, creatures of nature as we are, dying of hunger; why should men suffer more from it than these little ones? Every one, therefore, ought to find support on the ground he lives upon; but to do this we must take advantage of all the circumstances. If the ground is not sufficient for our wants, we should add to it the fruitfulness of water, subjected to our use. While the Western people have done much to utilize water wherever it seems available, there are, to my view, many defects in their management. I believe water is made to be used everywhere, and yet, notwithstanding the progress of science, this rule is not always conformed to in the West. With all their engineering works, well-water fails in the large cities, and that from the rivers has to be used. It is impure, and consequently unwholesome. In China, where we have had the same difficulty to contend with, we applied the remedy long ago by always boiling such water previous to using it—applying the anti-microbic remedy before the existence of microbes had been scientifically determined.

The efforts of our ancestors to subject the waters to their use date from an enormous antiquity; I have documents that show how this was done forty centuries ago. Notwithstanding the numerous modern inventions to facilitate the labor and manipulation, we have resolved the most difficult problems in such a manner that nothing can be shown to this day that surpasses what has been accomplished among us by the most primitive methods. By virtue of our system of irrigation our fields give us three crops a year without asking for any intervals of rest. Our liberally watered land is like a peasant woman ignorant of the refinements and weariness of the society woman, whose children follow one after another in the regular order of nature. This comparison may seem a little vague; but in China we believe that the sky is masculine and the earth feminine; that the one acts and the other produces; and that all fertility is the result of the

* An address, delivered July 26, 1889, before the Congress for the Utilization of Waters.

close union of these two constituent elements of our world. That is the fundamental idea of our agricultural and hydraulic philosophy.

The distribution of water by canals dates, in China, from the fabulous epoch. Having been carried on before letters and literature existed, we do not know what method was at first employed. In the year 2300 B. C., according to our annals, in the reign of the Emperor Yao, China was visited by a deluge extending over the whole empire. It lasted nine years, during which the whole country was a submarine domain. The waters of this flood were drained away by the enterprise of the Emperor Yu, our Noah, who employed seven years in dividing the country into nine regions, separated from one another by artificial water-courses which were like natural frontiers. After the water had been withdrawn he had the qualities of the lands of each province examined, and the products ascertained which they could afford; established the unit of land measure, and fixed nine classes of imposts, graduated according to the fertility of the lands and their situation. The conditions thus established lasted ten centuries.

In 1100 B. C. the prime minister of the Emperor Wou-Weng, Tcheou-Kung, constructed *norias*, or hydraulic machines of simple design and working, by which water was raised to a height to which it had never been carried before, and made reservoirs and canals for irrigation. Water was conducted, by means of machinery, from the wells to the dry hill-tops, and water provision was assured for times of drought. Agriculture, in consequence, flourished. Other measures of Tcheou-Kung comprised the promulgation of laws respecting the boundaries of properties and the prevention of trespasses. The fields were divided into squares called wells, from their resemblance to the Chinese character signifying a well, surrounded and furrowed by ditches so arranged that eight farmers, each tilling his own tract, united in cultivating the ninth, interior tract, which belonged to the state, and the produce of which paid their rent.

The system succeeded to a marvel. Each tenant was proprietor of about fifteen acres, the whole product of which belonged to him, while the state was really proprietor of the whole, and had, as a landlord, the income of the ninth tract. Besides this, each farmer had some 3,350 square metres of ground for his farm-yard and his mulberry-trees. Thus he always enjoyed a surplus of provision, of pork and poultry for food, and silk for clothing. No one at this time was richer or poorer than another, but a complete social equality existed, and every one, they say, was satisfied. The dynasty under which this system was established fell into decay about 600 B. C., when a period of feudal oppression set in that lasted for two hundred years. At the end of that time

Prince Houan-Kung, having obtained the supremacy in the kingdom of Tchi, returned to the system of Tcheou-Kung in a modified form. He appointed a minister and other officers of waters, who visited all parts of the country and attended to the execution of the works needed to prevent the visitation of the two great scourges of drought and floods. By these energetic measures the kingdom of Tchi was made the richest state of the time. When the Emperor Tsing-Tse-Houang, B. C. 250, reunited the Chinese Empire, he made the lands free to all, and imposed a tax instead of the cultivation of the ninth for the state. Previous to this he had constructed the Tcheng-Ko Canal, to conduct water from the King River to the Pe Mountain, by the aid of which some nine hundred thousand or one million acres of formerly sterile land were made fertile, so as by its increased wealth greatly to aid him in transforming his kingdom into an empire. Unhappily, he was dazzled by his great success. He allowed the canals to be neglected, and the country in consequence fell from its high estate of prosperity; and, as it is related in one of our historical books, "the dynasty of Tcheou, who founded the method of well-lands, survived for eight hundred years, with a happy people and prosperous landholders. Tsing followed an opposite policy, neglecting the canals; and his family only reigned for two generations, because so many of his people were ruined and their hearts were turned away from it." Thus the utilization of the waters had become a great political factor. This is not strange, because the Chinese are eminently an agricultural people. The system of Tsing was continued, except that the rate of taxation was reduced, under the Han dynasty, which arose 202 B. C. But after about three hundred and fifty years a series of inundations—the first that had occurred in two thousand years, or since Yu's time—began in the Yellow River and resisted all attempts to check them until a thorough method was adopted, under the direction of a special minister of hydraulic works. At the same time the productiveness of the land reached by the new canals was greatly increased. In the regions distant from the rivers irrigating wells were dug, and a period set in of activity in hydraulic works and general use of water which has not been surpassed.

The success of the proprietors who enjoyed the advantages of the irrigation works encouraged others to construct similar ones, each according to his means and for the advantage of his tenants. This method differed from that of Tcheou. The distribution of the lands was more unequal, but the regulation of the waters had been so perfected that the agriculture of the kingdom received a decided impulse; and China still has reason to thank the authors of the transformation for the permanent benefits it

has conferred. The works were extended and added to from time to time, and the construction of the canal Pé gave origin to a popular song celebrating the benefits derived from canalization. The transportation of rice by these artificial channels dates from the third century, when the Emperor Min-Te had a canal constructed which added more than 300,000 acres of land to cultivation and was used for the transportation of arms and provision. From this time there was more than enough food in China.

The efforts of the Thangs in the sixth century were less remarkable than those of their predecessors, because the more important enterprises had already been executed. The most noteworthy of these was the excavation of a lake in 624 A. D. by the celebrated poet Pe Ku I, who was also a prefect. It was supplied by the Tsien Tang River, and watered a space of between 90,000 and 100,000 acres. The dam was solidly built, but permitted the water to filter through in such a way as to fall slowly on the land below the level of the lake. The bank, planted with peach-trees and weeping willows, became a favorite promenade for *literati* and poets. The lake was crossed by six bridges, beneath which the flowers of the lotus waved, and the promenade was the first water-side pleasure-walk that existed in China. This lake was enlarged under the Sung dynasty by the poet Sou-Tong-Pao, who added what is called the outer lake. New dams were built, and travelers who resort to the lake are still able to admire the beautiful as well as useful work of the two great poets, who enjoyed also the rare privilege of being great engineers.

The Sung dynasty, in the ninth century, desiring largely to extend the system of canals, created a new department, at the head of which was placed a minister called the Governor of the Waters. Besides this, a superintendent of the transportation of rice was appointed to administer the northern provinces of the Yellow River, to whom were assigned the study of the regimen of the waters and the food-needs of the provinces, the classification of productive lands according to their value and position, and the supervision of the mulberry culture. This was the second period of Chinese agricultural prosperity. Another improvement was introduced in the tenth century, when sluice-dikes were invented which could be closed in times of flood and opened in dry seasons.

An overflow of the Tai Hu River in the province of Su Chiu, in 1160, moved the censor Li Kie to propose three projects to the throne: To make sluices and dams; to establish competitions among officers and others in plans for hydraulic works; and to take advantage of the fall and winter seasons of low water, when the people were not engaged on their farms, to employ them in constructing the works. The propositions were accepted, and the

works constructed in pursuance of them proved to be of great practical value.

The first emperor of the Ming dynasty, in 1360, gave orders to have the obstructed canals restored and reopened, so as to show that his first act was to think of the food and clothing of his people. When another flood occurred in the reign of Yung Lo, the work of repairing damages and providing permanently against future disaster was carried on day and night under the direction of the Minister of Finance, who mingled with the people and shared their labors. Under another emperor the very difficult and expensive works of what is called the "canal of multiple benefits" were completed, so as to furnish water to more than a million acres. The present dynasty, besides continuing the work of maintaining the canals, has published, under the Emperor Kien Lung, in 1737, a grand encyclopædia of agriculture and horticulture in seventy-eight volumes. The preparation of the work was intrusted to agriculturists and *literati*, who were careful to announce in the introduction that they had no intention of promulgating new ideas, but only to collate the most valuable methods and observations contained in the former works of the wise men of the empire. This cyclopædia is a store-house of valuable information concerning the utilization of water, and demonstrates the advance which the Chinese had made in extreme antiquity in that important branch of agriculture.

My country is essentially agricultural, and, in order that agriculture might prosper, we have applied ourselves, as you see, to give the land drink. The Emperor Yu, after he had delivered us from the flood, planned courses of water to flow over the land, as the Creator has furnished us with veins carrying the blood through our bodies. Confucius, speaking of Yu, said that all his efforts could be summarized in the creation of the canals. They were the motive force of the empire, and also an effective means of diminishing the destructive action of torrents and avoiding inundations. These prosperous times have continued the model and the ideal of China. The successors of Yu, whenever they deviated from the road that he marked out, saw all their dynasties extinguished in consequence of disasters caused by their neglect. The people have contributed their part to the depreciation of the water system. They have set water-plants on the water-sides to strengthen the marshy soil and gain new tracts of land, whereby the fields have been enlarged at the expense of the canals, while the farmers have not taken heed of the contraction of the liquid arteries. Then, in time, the water, not having sufficient outlet, would overflow. Our efforts are now devoted to making such things impossible, and to preventing the canals being obstructed by the encroachments of the land.

But while our farmer has the fault of trying to get too much out of water's-edge plantations, he is distinguished by many economical qualities. He has infinitely multiplied the branches of the artificial rivers that the wisdom of our emperors and their ministers has created; rich in numerous children, he has used their hands to subdivide the ditches and drain them through thousands of irrigating rills; and, in consequence of the constant presence of the precious liquid, he has realized prodigies in crops. Water permits him to use natural manure diluted to the fifteenth, according to the precepts of our sages, and to return to the land what man has taken from it. Water, always abundant, has furnished the means of applying the method of transplanting to the cultivation of wheat, and thereby getting larger returns; and it has made the constitution of small properties possible, and extreme subdivision of the land by which an intensive cultivation is secured for the smallest parcel. It is true that other factors, the patience of our peasantry, the wise organization of our mutual banks, and our inveterate habit of spending our money on the ground, have contributed much to our agricultural prosperity; but all these would have amounted to little in comparison if they had not been supplemented by the vast irrigating works.

I will add that without these gigantic works the Chinese could never have reached the high degree of perfection they have attained in one of the most important of their industries—pisciculture. Through the abundance of water everywhere, my countrymen, instead of being satisfied to cover the sea, rivers, and lakes with their fishing-boats, have been able to devote themselves extensively to the raising of fish. The spawn is carefully collected wherever it is found; instead of abandoning it to the channels of the rivers, the watchful shore-dweller puts it under protection wherever a suitable supply of water is to be found. The irrigation reservoirs are swarming with young fish. The fallow rice-fields, dammed and flooded in winter, are alive with wriggling carps; and even the rain-water cistern is turned into a breeding-pond.

This economical management permits us, without piscicultural societies, to stock the rivers with millions of fry, and to add a considerable variety of fish to our bills of fare, a part of which is consumed fresh, while the rest, salted or dried, is dispatched into all parts of the empire and sold at a moderate but always remunerative price.

As a whole, our system of water regulation may be regarded as one of the greatest achievements of the intelligence and labor of men. To it China owes very largely the comfortable condition of its innumerable inhabitants. It is not perfect, for it still leaves much to be desired; but we know well what is wanting.

and what must be done to supply it. If we had fancied that there were no defects in it, recent events, including the irresistible and disastrous overflows of Yellow River, would have demonstrated the contrary. They teach us that unceasing vigilance must be exercised in keeping the artificial waterways open, and that additional works are needed to make the system complete.

A difficulty resulting from the special character of our social organization stands in the way of the execution of new works. The whole of our territory is under cultivation. There is not a corner of the land capable of producing a crop that has not been devoted to some profitable occupation. To construct new canals, enormous sums additional to the expense of labor—very considerable at the cheapest wages—would have to be applied to the indemnification of dispossessed proprietors. There is also considerable diversity in the plans that are under consideration. Some favor the addition of new canals to the old ones. Others prefer vast basins, artificial lakes for the storage of the water of freshets, whence it may be drawn when wanted, to distribute over the country fertility instead of desolation. Formidable as the obstacles to immediate execution may be, we can foresee the time when these great works, indispensable to the completeness of our hydraulic system, shall have been brought to a good end. Then China, endowed with the grandest system of water distribution that the world has ever seen, will have nothing to do but to keep up the good condition of the work of the ancients with its modern additions.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

RICE AND ITS CULTURE.

By L. W. ROBARTS.

THE rice-plant (*Oryza sativa*) is a member of the grass family, and furnishes one of the most valuable grains known to economical science. It is cultivated, by the aid of abundant irrigation, in numerous varieties in most warm countries, and in the East Indies and China constitutes the principal food of hundreds of millions of human beings. The grain is also applied to mechanical uses in the arts, and the straw is one of the most highly prized materials of that class.

Ages before the discovery of America rice was cultivated in India, and is of volunteer growth in many parts of that country, "but principally on river-banks, where the seed was perhaps let fall." There is a wild rice preferred by the wealthy of Hindostan, but, on account of its small yield, it is not much grown.

There is no certainty of the place of the nativity of this valu-

able grain. The Chinese have much improved it by selection, which practice was in early years enforced by an imperial edict requiring the planting of only the largest grains. The most valuable variety grown in this country was secured by a South Carolina planter, who, upon observing some notably long grains upon a head, secured them, and so obtained the kind called the long grain. In the island of Ceylon there are one hundred and sixty-one varieties.

Various accounts are given of the introduction of rice into this country: one, that it was brought from the island of Madagascar toward the close of the seventeenth century, and planted in a garden in what is now one of the most thickly settled parts of the city of Charleston; and from this came the seed "that has made South Carolina the great rice-growing State." Another account claims that it was first grown in Virginia by Governor Berkeley, of unenviable fame, as early as 1647.

There are three varieties in the rice-growing States: 1. "White rice, valued for its earliness and for growing upon uplands, the husk cream-colored, and an ounce containing nine hundred and sixty grains. 2. The gold-seeded, with a deep-yellow husk, and large, fine white grain, eight hundred and ninety-six grains to the ounce. 3. The long grain, a sub-variety of the gold seed, having eight hundred and forty grains to the ounce; the grains are longer than any other, and it is the most valued for cultivation: for home use a long-awned variety, called the white seed, is often sown."

It is of the rice-fields of the tide-lands of the Georgia and Carolina coast, and of the adjacent islands, that we would speak. To those who have never been among them, these rice plantations would afford much that is both novel and interesting. This evergreen region, where the plaintive notes of the whippoorwill and song of the sweet-throated mocking-bird float up through the moss-covered trees; and negroes, fever and ague, rice-birds and alligators abound, would indeed seem to be a new world to our Northern brethren, and the picturesque effects charm the eye of the stranger artist. The rice-field darkey is himself a distinct type, totally different in both aspect and dialect from the negroes of the interior; and a not uninteresting sight is the force, as with song and shout they take their way along the embankment to the rice-field. Their ancestors for generations back, or, as they would tell you, "mi farrar an' mi granfarrar," have lived and labored in these malarial regions, and they accept chill and fever and other infelicities incident to these localities as unavoidable evils, plodding on with no higher aim nor hope, careless for the future, and not over-anxious for the present. The cost of living is small, as not many nor very warm garments are considered necessary, and the rice-field darkey's ideas of a wardrobe are extremely limited,

from both blissful ignorance and choice. Fish and game are plentiful, and in these regions a heavy diet is to be indulged in only at great risk. Free labor is found to be more remunerative than slave, inasmuch as the idle or inefficient can be dismissed; and the rice-planter of to-day has not necessarily the care of the sick nor the doctor's bills of the *ante-bellum* time, when the very best physicians were employed. Then, again, there is the wonderful relief from anxious care; and the providing in every way for the wants of a large plantation of negroes, great and small, was no sinecure.

The best rice-lands are on the banks of rivers, for the convenience of flooding by the opening of the tide-gates, and also of conveying the grain to the mills. They must be so situated as to escape the salt and brackish water, but be below the reach of freshets, which are often most disastrous. They are alluvial lands, composed principally of decomposed vegetable matter, and when dry have the appearance of soot. Good crops can be made on other low lands, if so lying that they may be drained and flooded at will. These plantations have been and still are valuable possessions. It costs no inconsiderable sum to get them in order for planting, though less than formerly, as the planter of to-day cultivates fewer acres. The land is regularly laid out by a complete system of embankments and ditches, forming independent fields—the size of the fields being limited by the number of hands that can finish one day's necessary work of cultivation in a day, usually from fourteen to twenty acres.

The plantations are surrounded by a dam or levee, with floodgates and trunks, through which they are irrigated from the river. They are divided in squares, banked in, with a large ditch near the banks, which receives the water from the trunks for irrigation through smaller ditches fifty feet apart, through which the fields are also drained at ebb-tide.

Rice Culture.—Early in the winter the water is all drawn off, that the banks may be strengthened, ditches mended, and the ground plowed or hoed. In warm changes the water is again turned on. In March drains are cleansed, ground kept dry, clods broken up, and all made smooth with harrow or hoe. In April, and until about the middle of May, the grain is sown in trenches, a four-inch trenching-hoe being used, running at right angles to the ditches, and about sixteen inches apart. By some the fields are cross-plowed, and the grain dropped at the intersections. The seed is very carefully selected, and sometimes, in order to secure only the fullest grains, the rice is thrashed by hand over a log or barrel. The seed, when sown, is lightly covered, and the water turned on and kept upon the field from four to six days, until the grain swells and begins to sprout. If the seed is not to

be covered, it is mixed with clayey water and dried, when a sufficient quantity of clay adheres to prevent the grains floating off when flooded. With the first method the water is again turned on in the "sprout-flow," when the plants sprout "and appear like needles above the ground"; with the latter one flooding is sufficient. When the water has been on the sprout from four to six days, it is again drawn off; and when the plants are six weeks old, they are lightly hoed, and the hoeing is repeated in ten days.

Now comes the stretch-flow, when the young plants, several inches high, are flooded for two weeks and helped in their struggle for light and air, and, strengthened and invigorated by their native element, grow apace; water kills the weeds, but nourishes the rice. The water is now put down to the "slack-water" gauge, and if, as is generally the case, the plants are longer than the water is deep, the upper leaves float "in long, waving lines upon the surface"—a pretty, refreshing picture, once seen not soon forgotten. The water is gradually drawn off, and eight days after, when the field is dry, the ground is deeply hoed.

Volunteer rice, which is treated as a weed, often springs up with the regular crop. It is both hardy and prolific, and a great pest to the rice-planter. It can generally be removed by the hoes; then again it necessitates replowing and sowing, while sometimes the fields have to be thrown into dry crops for a year or two, or to remain flooded for that length of time. When harvested with the white, this red or volunteer rice greatly reduces its grade, and also renders it unfit for seed.

At hoeing-times a picturesque scene is presented, with say from fifty to one hundred men and women abreast, busily plying their hoes; the former in the utmost *négligé* of a laborer, and the latter with short, scant homespun dresses and leggins, *all* with broad-brimmed straw hats, or, in the case of the women, the head kerchiefs of the olden time. In the mouth of each is a stick, on the end of which is stuck, and smoking, a small piece of the punk taken from the heart of the oak. This smoke is for the purpose of driving away the myriads of "pesky" sand-flies that are more than enough to drive one wild, sometimes so thick that they have been known to cast a shadow. A young man, whiling away a summer holiday by a visit to the rice-field, essaying the same but to him untried expedient, and not understanding the manner of procedure, kept puffing away as if smoking a cigar, and soon had the punk in a bright blaze, so that he suffered the unpleasant consequences that await the inexperienced; there is something to be learned even from an ignorant rice-field darkey.

But in writing of rice and rice-fields I must not forget to give some prominence to the ravaging army of birds that feast upon the tender sprout and ripened grain, sometimes almost or quite

appropriating the crop. The rice-bird proper of Georgia and Carolina (*Emberiza oryzivora*), the reed-bird of the Middle States, and the bobolink of the North and West, is one and the same. It is about the size of a sparrow, and, while of grave and somber coloring during some months of the year, again decks itself in livelier plumage; and the quick, merry songs which enliven the grassy meadows during the breeding season, give place later to a "short, sharp chirrup." They are migratory, spending their winters mainly in the Western Isles. They come to the Southern States in early spring, leave, and return to the rice-fields in September and October. Continual war is waged against them by the rice-planter, and they are annihilated by the hundreds by the rusty muskets of the old darkey and the army of negro women; and one-garmented, short-skirted, dirt-besmeared urchins, who, by dint of "cracking" whips, and a continual switching at them, manage to at least mitigate the evil and give the persecuted rice a chance to grow. These little darkeys are sometimes negligent, and one of the old "drivers" used to say, "I gie um a licking, sah, fo dey go in fuh mek show ob dere bein' fateful."

Then, again, the rice-bird falls at the hands of the rapacious sportsman, who frequently by one shot puts an end to a *half-dozen dozen* little lives; and sometimes weary of gathering the plump little mouthfuls, so fat that they have been known to burst in falling, leaves many in the field, at the same time bearing home with him far more than "four-and-twenty" rice-birds to be "baked in a pie."

But to return to our more special subject. When the plant shows a joint the last hoeing is given, and the crop is "laid by" by the opening of the flood-gates, and turning on of the "joint water" or "harvest-flow," for the support of the plants, the field remaining under water until the grain is fully ripe, which may be two months. When matured, a few days before harvesting, the field is finally drained, and the ditches cleansed by the "succeeding tide."

HARVEST.—The rice is cut with sickles, the use of heavy machinery being impracticable in a rice-field. The crop is now left to dry; but the day after cutting, when free from dew, is tied in bundles, which are piled in ricks or upon platforms on the canals and rivers, so arranged as to shed the rain, until taken off by the barges to the thrashing-mills; these flats carry each the harvest of from five to seven acres.

AFTER HARVEST.—Now comes the gala day of the rice-field laborer, when the crop is being taken to the mill to be thrashed. The barges are numbered, say from one to ten, and great are the excitement and rivalry of the men in command, the same state of feeling pervading the whole force. With flags flying they bend

their full energies in the race from the fields to the mill, and long and wild are the exultant cries from the captain and crew of the barge that first moors at its destination and wins the prize offered by the planter. After this great exertion the careful master of the *ante-bellum* time generally dealt out to his slaves the expected grog, and required a bath and change of clothing.

THRASHING, ETC.—This is done by machinery: a thrasher much used was invented by Calvin Emmons, of New York. It separates the grain by tooth-beaters, which make from seven hundred and fifty to eight hundred revolutions per minute. The barge containing the bundles of rice passes under the mill, and its load is elevated by hooks to the floor above. When thrashed, if the crop is small, about five thousand bushels, it is put in sacks; but if large, say about forty thousand bushels, the paddy or rough rice is poured down a flume from the mill to the hold of the schooner in waiting, and is next taken to the cleaning-mill, which is frequently owned by the speculator that purchases it; and, when the grain is hulled, he in his turn sells it to the merchant.

By the *old* method the chaff was removed by pounding in hand-mortars hollowed out of pitch-pine blocks; it is now hulled by steam-power. When ready for market, the rice is put into barrels holding about six hundred pounds. The average of several analyses of rice gives—of albuminoids, 7·5; carbohydrates, 76·5; water, 14·6; ash, 6·5. Rice constitutes the food of almost one third of the human family. It is used in rice-meat and various aromatics, fermented and distilled into arrack, molded into models and busts, and is employed in paper-making, cement, and starch; the chaff, broken rice and dust, makes valuable food for cattle; the straw is sold for forage and bedding, and is also used in the manufacture of bonnets, while the Southern housewife can tell of the use of rice-flour in the making of delightful breads.

The total rice crop in 1870, according to the Federal census, was 73,635,021 pounds, a decided falling off from 215,313,497 pounds in 1850, and 187,167,032 in 1860. The yield for 1879 was better, being 110,131,372 pounds. Charleston, S. C., is the great rice market of the United States. The American grain is much preferred to the imported, and, as the demand is far greater than the supply, there is still ample room for the rice-planter.

IT is observed, in Dr. G. M. Humphrey's book on Old Age, that the fertility of long-lived persons is above the normal, and in some continues to an advanced old age. The effect of the combination of conditions must be to give the stock of long-lived people an advantage in the race for existence, so that one would expect their number, in proportion to the rest of the population, rapidly to increase. This may help to account for the greater number of aged people, and the prolonged continuance of vigor among them.

SKETCH OF RENÉ DESCARTES.

PROF. HUXLEY, comparing the thoughts of men to the leaves, flowers, and fruit upon the branches of a few great stems bearing the names of the half-dozen men of strongest and clearest intellect, is of the opinion that "the thinker who more than any other stands in the relation of such a stem toward the philosophy and the science of the modern world is René Descartes. I mean," he adds, "that if you lay hold of any characteristic product of modern ways of thinking, either in the region of philosophy or in that of science, you find the spirit of that thought, if not its form, to have been present in the mind of the great Frenchman."

The London Spectator, reviewing Prof. Mahaffy's life of the philosopher, regards him as presenting the spectacle of a twofold life. "He was a man of society; he was a philosopher—the two were so completely distinct that they never came into collision. On the one side, he was inflexible, a pillar of intellect never deviating by a hair-breadth from rigid perpendicularity; on the other, he was all things to all men. For his intellect, the law was rejection of authority, assertion of absolute freedom; for the rest of him—for the man, distinguished from the philosopher—the law was courteous compliance all round."

RENÉ DESCARTES was born at La Haye, Touraine, France, March 31, 1596, and died in Stockholm, Sweden, February 11, 1650. He was the second son and third child of Joachim Descartes, who, having done some military service, had purchased a commission that gave him a place in the *demi-noblesse*. He inherited from his mother, who died at his birth, a feeble constitution, the marks of which he bore through life, and by reason of which the doctors predicted that he would die young; was baptized and brought up in the Roman Catholic faith; and betrayed from early infancy an insatiable curiosity and a disposition to inquire into the causes of things, which led his father to call him his philosopher. At eight years of age he was sent to the College of La Flêche, of the Jesuits, where he was remarked for his studious habits and the rapid progress he made in the knowledge of the ancients and in history. His delicate health seems to have contributed to his advance in scholarship, inclining him more to study than children of robust constitutions, and securing his exemption from morning duties, whereby he acquired the habit of meditating in bed. In that position a great part of the real work of his life was done. He accounted for his fondness for books by suggesting that the reading of good books was like a conversation with the brightest men

of past times, but superior to ordinary conversation because the speakers presented only their best thoughts.

Besides the text-books of the school, he was fond of reading such books as treated of curious and rare knowledge, and he had a high esteem for eloquence and poetry as gifts of genius rather than fruits of study. Those who can give clear and forcible expression to their thoughts, he said, though they spoke in Bas Breton and had never learned rhetoric, could always exercise the most persuasive power; and those who have the most pleasant fancies, and can express them most gracefully and with pertinent illustration, will not fail to be the best poets, though they have never studied the poetic art.

As the breadth of his knowledge enlarged, he grew more disposed to estimate the value of what he studied by its capacity of being made useful in life. He perceived the deficiencies of the logic and morals and of the physics and metaphysics that were taught in the college, and gained an increasing appreciation of the merits and beauty of the mathematical sciences. One of his first steps after leaving the college, he informs us in his Discourse on Method, was to discard his books, with all that he had learned that was uncertain, and to admit thenceforth only what seemed to have been demonstrated by reason and experiment. He therefore framed the method of examination and doubt, which, although he failed in very many instances to be true to it, has since become the great principle of positive science. He did not, however, he says, "imitate the skeptics, who doubt only for doubting's sake, and pretend to be always undecided; on the contrary, my whole intention was to arrive at certainty, and to dig away the drift and the sand until I reached the rock or the clay beneath."

After leaving the college, at the age of sixteen, he returned to his father, and in the next year went to Paris to participate in the social life of the capital and continue his studies. He renewed his school-day friendship with Marin Mersenne, now become Père Mersenne, of the Minim Friars, forming what proved to be a lasting alliance, and became associated with Claude Mydorge, one of the foremost mathematicians of France. Giving up the social side of his life, he withdrew for retirement and study to a secluded quarter. There is reason to believe that he made at this time some of his important geometrical studies, but he was not ready to publish them. A military career afforded at this age the most feasible means of getting the broadest views of life, and Descartes, in May, 1617, when twenty-one years of age, set out for the Netherlands and entered the service of Prince Maurice of Orange. Two years later he joined the forces of the Duke of Bavaria in the war between the house of Austria and the Protes-

tant princes. While in garrison at Breda, he saw one day a placard in Flemish to which the attention of a considerable crowd had been attracted. It was the statement of a mathematical problem, to which the author, after the fashion of the times, invited solutions. Not understanding the language in which it was written, Descartes asked one of the bystanders to translate it to him. This man was Beeckman, Principal of the College of Dort, himself a mathematician. Surprised to find a young soldier interested in such a matter, Beeckman explained the terms of the challenge with his most learned air. Descartes said at once that he would solve the problem, and brought the solution to Beeckman on the next day, having mastered it in less than an hour. The winter of 1619 was spent in quarters at Neuburg, on the Danube, to a large extent in study, and was, according to Dr. William Wallace, in the Encyclopædia Britannica, the critical period of Descartes's life. "Here, in his warm room, he indulged those meditations which afterward led to the Discourse on Method. It was here that, on the eve of St. Martin's day, he 'was filled with enthusiasm, and discovered the foundations of a marvelous science.' He retired to rest with anxious thoughts of his future career, which haunted him through the night in three dreams, that left a deep impression on his mind. 'Next day,' he continues, 'I began to understand the first principles of my marvelous discovery.'" In the next year he sought out the Rosicrucians, to obtain some knowledge of their supposed mystical wisdom, but without success. Descartes retired from military life upon the defeat and death of Count Bucquoy at the hands of Bethlen Gabor's revolted Hungarians in 1621.

During his career in the army, Descartes composed a Latin treatise on music, which he intrusted to Beeckman. It was surreptitiously copied, and was published without the knowledge of the author in 1618. It seems to have been considerably successful, and was reprinted several times and translated into English and French. But Beeckman's treachery cost him Descartes's friendship. Among other writings of this period, unpublished or lost, but mentioned in the catalogue prepared by Chanut on the order of Queen Christina of Sweden, are General Considerations on Science; a fragment on Algebra; Democritia, or Fugitive Thoughts; Experiments, or a Collection of Observations; and a collection of mathematical speculations entitled Parnassus. Descartes continued his travels in a private way, having in view, as he expressed his purpose, to look into the courts of princes, to become acquainted with men of different humors and different conditions, to inform himself concerning the natural products of different climates and the various civil usages and customs observed among different peoples; and to seek in the great book of the world knowl-

edge that could not be acquired elsewhere. From his observations he gained the great advantages of learning to believe nothing lightly, and not to hold obstinately to the things which example and habit had accustomed him to believe. He visited Holland, France, Italy, Switzerland, the Tyrol, Venice, and Rome. At Venice he witnessed the ceremony of the wedding of the Doge with the Adriatic. He made a pilgrimage to the shrine of Loretto.

Returning to France, Descartes entertained for a time the thought of purchasing a position as lieutenant-general of the province, at Châtellerault, but the legal chicanery connected with the office was not to his taste, and he gave up the scheme. He then took lodgings in Paris, and lived in the style of a modest gentleman at ease. He gathered a few friends around him, among whom were Mersenne and Mydorge, who were interested in the problems of the refraction of light; and together they experimented in the grinding of lenses. With others who came to witness the experiments, the house became a kind of academy, and too busy a resort to favor Descartes's studies. Meetings of literary men and students had become common in Paris, the more important ones being held with the Papal nuncio and Cardinal Richelieu. Descartes, urged by his friends, attended them frequently. He had, in his reflections on the choice of a position, become confirmed in the thought that he should not confine himself to any business, but should devote his life to the cultivation of the reason, and to advancement by every possible means in the knowledge of the truth according to the method which he had prescribed. At one of the meetings Cardinal de Bérulle was struck by a remark of Descartes's that the true art of memory was not to be gained by technical devices, but by a philosophical appreciation of things. He was thereby prompted to urge upon him a plan of life in almost exact accord with his conviction.

His associations in Paris, with their distractions not being favorable to the close attention which he sought to exercise to qualify himself for the execution of his purpose, Descartes determined to retire to some place where he could be alone and could pursue his studies untrammeled. He went to Holland, where he found variety and congenial retreats during the period from 1629 to 1649 in thirteen different places, and where he composed or revised most of his works. In the choice of these residences he seems to have been influenced, according to Mr. Wallace, by the two considerations of the neighborhood of a university or college, and the amenities of the situation. He appears to have also had a decidedly religious inclination. He found Franeker, the seat of a university, very agreeable, because it afforded him opportunity for attending mass, and gave him freedom in the religious exercises on which his attention was apparently most fixed during the

first nine months of his residence. He wrote from Amsterdam to Balzac, who had expostulated with him for having withdrawn himself from the world: "In this great city where I am, there being no one except myself who is not in trade, every one is so intent on his speculations that I might stay here all my life without being seen by any one. I walk out every day amid the confusion of a great people with as much freedom and peace as you could have in your garden walks, and I pay no more attention to the men who pass before my eyes than you would to the trees in your woods and the animals feeding there. Even the noise they make works no more interruption to my thoughts than would the rumbling of a brook." He resumed his studies in dioptrics. Observations on parhelia gave the origin to his treatise on Meteors. He entered with great ardor upon the study of medicine and anatomy, and visited the butchers' shops every day to witness the slaughter of animals, of which he brought parts home to his rooms to be dissected at his leisure. His correspondence with Père Mersenne abounded in mathematical problems which the two exchanged with each other. He studied astronomy and composed his Traité du Monde, in which he avowed the doctrine of the motion of the earth. On learning, however, of the condemnation of Galileo, he suppressed this book, saying, in a letter to Père Mersenne: "All the things I have explained, although I believe them to be supported by very certain and very evident demonstrations, I would not for the world maintain against the authority of the Church. . . . My desire to live in quiet and continue the retired life I have begun makes me more content to see myself delivered from the fear of having gained more fame than I wished for by my writing, than sorry for having lost the time and trouble that I have taken in composing it."

Descartes made three visits to France during his residence in Holland. The first was in 1644, to settle family affairs after the death of his father in 1640; the second was signalized by an award to him of a pension secured by Cardinal Mazarin of three thousand francs, in consideration of the advantages which his investigations had conferred upon mankind, and to aid him in continuing them; the third visit ended in disappointment, for the substantial results anticipated from it were nullified by the breaking out of the civil war of the Fronde. During the second of these visits he is said to have met Pascal, and suggested to him the thought of experimenting on the weight of the air. A visit was made to England for the investigation of magnetic phenomena, and in 1634 Descartes took an excursion into Denmark.

A controversy in 1638 with Fermat concerning that author's book on Maxima and Minima, and on tangents, engaged the friends of both parties, and resulted in a friendship between the

chiefs. Descartes had other discussions—with Petit on dioptrics, Morin on light, Beaugrand on geostatics, Roberval on the line described by a nail on the outside of a wheel in motion, and with Voët, Professor of Theology at Utrecht. The last controversy, which was brought on by Voët's criticisms of the indiscreet utterances of Descartes's disciple, Regius, resulted in Descartes being summoned before the magistrates of Utrecht on charges of irreligion and slander. He escaped the threatened prosecution by claiming the protection of the French ambassador and the Prince of Orange. An order forbidding all mention of the name of Cartesianism at the University of Leyden was likewise annulled by direction of the Prince of Orange.

Queen Christina of Sweden, interested in her way, although she was not yet twenty years old, in matters of literature and philosophy, having heard of the great fame of Descartes, conceived a desire to become acquainted with him. He was drawn into a correspondence with her through Chanut, the French ambassador to Sweden, to whom he sent a dissertation on Love, which was intended for her. He followed this with an essay on the Chief Good, addressed directly to the queen. Finally, she invited Descartes to go to Sweden and give her lessons in philosophy. Descartes acceded to the request after considerable hesitation. He reached Stockholm in October, 1649. The queen was very exacting in her demands on the philosopher, and required, among other things, that he attend upon her every morning at five o'clock. The hardship of this duty, which did violence to his life-long habit of lingering in bed, with other incidents of his life at the Swedish capital, combined with the rigor of the winter climate, were too much for Descartes, and entailed upon him a pneumonia, from which he died.

The written works of Descartes were collected and published in Latin in 1670–'83. A selection from them was published in Paris in 1843, and a collection of his moral and philosophical works in 1855.

The earliest work was the Discourse on the Method of Reasoning Well and Seeking the Truth in Science, which, besides the exposition of general principles, according to the description in the title, contains treatises on Dioptrics, Meteors, and Geometry, the general scope of which is indicated by their titles. The central propositions of the whole Discourse, according to Prof. Huxley, are: "There is a path that leads to truth so surely that any one who follows it must needs reach the goal, whether his capacity be great or small. And there is one guiding rule by which a man may always find this path and keep himself from straying when he has found it. This golden rule is, Give unqualified assent to no proposition but those the truth of which is so clear and dis-

tinct that they can not be doubted." Descartes attached less importance to the geometrical and mathematical methods of which he was the inventor than to his moral and metaphysical speculations. But, while the latter have been sifted and riddled in discussion, and have suffered under the revolutions of thought, the mathematical principles he established and the methods he introduced remain. In geometry he gave demonstrations of general principles, under which solutions adapted to one problem could be applied to all like it. In algebra, for the old clumsy notation and nomenclature, always suggesting material relations, he substituted the beautiful, convenient system, purely abstract, by the aid of which that branch of the science has marched to almost universal application and perfection. And in the application of algebra to geometry, he introduced the method of abscissas and ordinates, by means of which any curve and any condition of form can be computed by a process as beautiful as it is direct.

The Meditations on the First Philosophy, which appeared in manuscript in 1640, consists of six parts, in the first of which the author expounds his philosophy of doubt; in the second, he reaches the certainty of his own being, through the use of his famous maxim, *cogito, ergo sum* (I think, therefore I am); in the third, he deduces an argument to prove the existence of God from the idea of an infinite and sovereignly perfect being; in the fourth, he draws a distinction between speculative reasoning, for which the light of nature is sufficient, and doctrines of faith and the conduct of life, which rest on another foundation; in the fifth, he explains the corporeal nature, and brings forward another argument for the existence of God; and in the sixth he treats of the distinctions between intellect and imagination, the difference yet intimate connection of soul and body, errors of the senses and the means of avoiding them, and the reasons upon which we can conclude concerning the existence of material things, which he, however, regarded as inferior to the evidence on which we predicate the existence of God and the soul. The book in this form was submitted to the criticisms of a number of distinguished students, whose objections were printed and bound with the main treatise when it was published in 1641, and with them the replies of the author, considerably swelling the bulk of the volume.

The Principles of Philosophy, 1644, contained an exposition of the principles of knowledge as developed in the Meditations; an explanation of the primary laws of nature, the properties of matter, space, motion, etc.; the system of the world, the sky, and celestial bodies; and a treatise on the Earth. The statement of the three laws of nature, the seven secondary laws of impact (which are pronounced by later science to a large extent incorrect), and the famous theory of Vortices, by which Descartes at-

tempted to account for the structure of the universe, are contained in this work. The first of the three laws affirms that every body, so far as it is unaffected by extraneous causes, always perseveres in the same state of motion or rest; and the second that simple or elementary motion is always in a straight line. "These doctrines of inertia, and of the composite character of curvilinear motion," says Mr. Wallace, "were scarcely apprehended even by Kepler or Galileo; but they follow naturally from the geometrical analysis of Descartes." He taught that extended matter has no limits to its extent, though the power of God has divided it by lines discriminating its parts in endless ways. He denied the possibility of a vacuum, and the existence of atoms or ultimate particles, and regarded matter as uniform in character throughout the universe—all of which views are consistent with what may be logically deduced from the results of the latest investigations. In the universe packed with matter, no particle can move unless all the others move too. Hence we have universal motion, taking the form of "a host of more or less circular movements, and of vortices or whirlpools of material particles, varying in size and velocity." These vortices, which were supposed to give rise to three kinds of matter and to the phenomena of radiating light, were made to account for the existence and motions of all the stars and systems, the sun and planets, and the earth. Descartes applied his vortician theory not only to all the phenomena of physics, but also to those of organic life, including that in animals and man; whence he ventured to show that man and the animals are really machines, with the single difference that man has a rational soul, while the animals have not. In the Treatise on Man and the Formation of the Fœtus, which was published after his death, Descartes expounded the doctrine of animal spirits. Other works are the Treatise on the Passions of the Soul, which was translated into French for Madame Elizabeth, Princess Palatine; and the Rules for the Direction of the Mind, a posthumous work. Descartes was never married, but he is believed to have had a natural daughter, Francine, who died when she was five years old. He is described as having been "a little man, with a large head, projecting brow, prominent nose, and eyes wide apart, with hair coming down almost to his eyebrows," and feeble voice, and as usually dressed in black.

On his death, Queen Christina wanted him buried with the kings of Sweden; but Chanut, who is supposed to have carried out his wishes, had his body modestly interred in the cemetery of the Orphans' Hospital, where Catholic foreigners were usually buried. Thence his remains were a few years afterward transferred to France, where, after several changes, they were finally deposited, in 1819, in the Church of Saint Germain des Prés.

EDITOR'S TABLE.

SIR WILLIAM DAWSON ON EVOLUTION.

SIR WILLIAM DAWSON, the well-known Canadian geologist, has brought out, under the auspices of the Religious Tract Society of London, England, a work entitled Modern Ideas of Evolution as related to Revelation and Science. The title of the book, we must say at the outset, seems to us a little peculiar. Any idea of evolution (as the term is now understood) must, if considered at all, be considered in relation to science; but how to consider it in relation to revelation is not, to our mind, easy to understand. How are ideas of evolution to be brought into direct relation with revelation as a substantive fact? If revelation is a substantive, self-evident fact, then there is no use in bringing any ideas of evolution into comparison with it. The Arab leader who burned the library at Alexandria did not want to compare any of the books contained therein with the Koran, but summarily said: "They either agree with the Koran or disagree with it. If they agree with it, they are superfluous; if they disagree with it, they are noxious: in either case burn them." In like manner, no one who reads the laws of nature in the blaze of an all-sufficient revelation will want any other light. Had Sir William spoken in the title of his book of bringing "ideas of evolution" into relation with "*ideas* of revelation," the proposition would have appeared a more hopeful one, and would have contained a certain suggestion of fair play; but to bring mere "ideas" on the one side into direct contact with the most absolute and commanding reality on the other, seems—well, not quite the right thing to do. Give the "ideas of evolution" a chance; let there be something to "umpire."

Sir William Dawson has written this book for a select circle of readers—a wide one possibly, but select nevertheless—readers who appreciate such a description of Darwin as the following: "Darwin, as he sits in marble on the staircase of the British Museum, represents a noble figure, made in the image of God, and capable of grasping mentally the heaven above as well as the earth beneath. As he appears in his recent biography, we see the same man paralyzed by a spiritual atrophy, blinded and shut up in prison and chained to the mill of a materialistic philosophy where, like a captive Samson, he is doomed to grind all that is fair and beautiful in nature into a dry and formless dust." It is needless to say that a reader at all accustomed to scientific method would wish to know exactly what is meant by ability to "grasp mentally the heaven above as well as the earth beneath." Darwin, it seems to be admitted, grasped the earth beneath: in order to grasp the heaven above—interpreting the words in a natural sense—he would have had to be an astronomer in addition to being a great biologist and naturalist. The writer, however, does not use the words in their natural sense: by the "heaven above" he means some supernatural order of facts; but could he, as a scientific man, tell us of any one who to his positive knowledge had "grasped the heaven above" in that sense? When Darwin grasped the earth beneath he could tell us what he grasped, and the world is vastly the richer to-day for the positive knowledge imparted by him in regard to terrestrial facts. But could Sir William Dawson himself enrich the world by imparting what he has grasped of "the heaven above"? What does he know about it that he can communicate in distinct speech? If he has any such information, it would vastly surpass in interest anything he can tell us about

the *Eozoön canadense;* but we venture to say that, in spite of his slur upon Darwin for not having grasped this kind of knowledge, he does not himself possess one particle or scintilla of it that he could teach as fact to any human being.

Then what are we to say about the accusation against Darwin of grinding "all that is fair and beautiful in nature into a dry and formless dust"? All that we can say of it is that it is false, and, as coming from a man of recognized scientific position, deplorable. Nature to Darwin was full of interest to the last; and few men have done more than he to awaken an interest in and love of nature in others. We have only to read his correspondence with the foremost naturalists of the time to see what a center of interest he was to them, and what a living thing the study of nature under his guidance, or upon lines indicated by him, had become. The fact is that organic nature was never so interesting a subject of study as it is to-day; and few will deny that this is due, in large measure, to the influence of Darwin—the man who is now accused of turning "all that is fair and beautiful in nature into a dry and formless dust." When people who claim to "grasp the heaven above" indulge in such unfounded and uncharitable remarks about their intellectual superiors, one is apt to wonder whether their prehensile powers have really been exercised to the best advantage.

That Sir William Dawson did not write this book for a scientific public is evident by many signs. When he speaks of standing near to the "treacherous margin" of the evolution philosophy and rescuing a few grains of truth, he writes—there is but one expression for it—utter nonsense. Imagine for one moment a scientist, a philosopher, stealing gingerly to the edge of a system of philosophy and putting out a timorous hand to clutch a grain of truth, whirling, as it were, in a vortex! Imagine the scientist, the philosopher, dreading to be sucked in, and quickly retreating with his rescued grain to a safer footing! Again, when he tells us, in effect, that the controversy between Huxley and Harrison supplies "an evidence of the need of a divine revelation," we are persuaded that such an utterance could only have been intended for very shallow minds. More need for a revelation, we should say, if Harrison and Huxley agreed, for how should we know that they were not both in error? When they disagree, there is at least a probability that the errors of the one will more or less cancel those of the other, and that some residuum of truth will be left behind. It is hard to see how truth could be established except by conflict, or how minds could develop except through contact and collision with other minds. Think what a lot of simpletons we should become if, as often as a difference of opinion arose, instead of being left to weigh the arguments on either side, we were at once to hear an authoritative voice deciding the whole question! It will greatly please most of the readers of this book to be told that Darwin took a very "unscientific" position in "enthroning chance or accident or necessity as Lord and Creator"; and it will not trouble them in the least to remember—if they do remember—that, on the immediately preceding page, it was stated that "Darwin's natural turn of mind and his scientific training were not of such a character as to lead him to seek for ultimate causes; he was content with a modal evolution (i. e., with evolution considered and treated as a method); he took matter and force as he found them." The two statements are in obvious conflict, and the one on the earlier page is the correct one. Darwin did not enthrone chance; he took matter and force as he found them; and to us his position appears entirely scientific. Herbert Spencer, by a long course of reasoning, arrives at the conclusion that the First Cause is inscrutable. Darwin assumed as much without going through

any troublesome logical process. Nobody in this world, except perhaps some superstitious gambler, ever "enthroned" chance, and even he is imposed upon by words.

One is compelled to ask the question whether the author is as inapt at philosophical reasoning as his book indicates, or whether he has simply put aside his philosophy in order that he may not affright the babes to whom it is his evident purpose to minister. He tells us that it is "a striking inversion of ordinary probabilities" to suppose that the environment can influence the development of organisms; that inanimate nature can "rule, determine, and elevate that which lives and wills." Does not the law of gravitation rule and determine in a very great degree nearly all the phenomena of human life? Does not diet determine the quality of the blood, and the quality or condition of the blood influence thought? Is not civilization largely a matter of climate and general physical conditions? The world might have been much better than it is, we are told, if it had pleased God "to produce a superior race of beings." This is Sir William Dawson's dictum: we know nothing about such matters; all we know is that no race superior to man has been produced; and we are disposed to conclude that man, as he is and has been, stands in definite relation to the condition of things on this planet. That a being of infinite power, who might have done better, should have been content with doing worse, is an idea which we prefer to leave to the contemplation of the author. Another example of what may well be called baby philosophy is where, speaking of the idea that there may be among the organs of the body a certain struggle for existence and pre-eminence, our author declares it to be "revolting to common sense and hideous to right feeling." What has a student of science to do with any idea put forward as scientific except to bring it, if possible, to the test of facts? To us it is no more "revolting" or "hideous" that there should be a struggle for existence going on between the different cells of our body than that the movement of the earth in its orbit should be the resultant of two antagonistic forces, or that our social system should be the result of the competing activities of its individual members. "On this view," says our author, "the mechanism of an animal ceases even to be a machine, and becomes a mere mass of conflicting parts thrown together at random, and depending for its continued existence on a chance balance of external forces." Does the solar system cease to be a machine because it is controlled by the rival laws of gravitation and inertia—because the planets are acted upon at once by a centripetal and centrifugal force? Does the social organism cease to be a machine because its balance is maintained by the self-seeking and mutually-limiting activities of its members? To talk of "a *chance* balance of external forces" is irrelevant and meaningless. What we know is that there *is* a balance, that it has endured long enough for the development of an infinite number of organic forms in adaptation to it, and that there is no apparent reason why it should not continue. That is all any one who is determined not to transcend the facts can say. We have not space to examine the more detailed reasonings of the author of this book; but its general philosophic tone may be correctly judged from what precedes. It is not a book that will enhance the reputation of the Canadian scientist.

THE AMERICAN ASSOCIATION.

THE meeting of the American Association just held at Indianapolis may be regarded as one of the best of recent years. The attendance was up to a good average in numbers and embraced a good many distinguished names, both among the older and newer generations

of workers. Ample accommodations were provided in the new State-House, where all the meetings could be held under a single roof. The citizens of Indianapolis, who as a community are busy in turning the achieved results of science to profit, were enthusiastic in welcome and kindnesses.

The more noteworthy papers, including the official addresses, well befitted the name of the body, and were true to its declared purposes of promoting intercourse between students and encouraging more active and more systematic research; and a considerable proportion of them were at the same time happily adapted to the average intelligence of a public audience and in the direction of popular questionings.

Retiring President Mendenhall treated in his address of the relations that exist and should exist between scientific students and the public. While he sought to determine how far men of science are responsible for any lack of cordiality that may exist, he demonstrated to business men, by means of a very happy illustration, that they are enjoying direct benefits from the results of abstract research to a far greater extent than they realize or imagine. His remarks, on both sides of this subject, deserve particular attention. Vice-President Branner, considering the relations of State and National Geological Surveys, endeavored to sketch a plan of combined action, under which the party of either side could do the work proper for it without encroaching upon the field of the other, and room be left for individual research. Vice-President Dodge, in the Economic and Statistical Section, set forth in a pleasant light the advantages enjoyed by the producing classes in the United States in relation to the standard of living. In relating the present condition of knowledge respecting the variable stars, Prof. Chandler had a subject that involves research of the highest order, of which at the same time every one desires to be informed. In a large number of the sectional papers, too, the sober dignity of the scientific method was combined with adaptation to the tastes of hearers of a practical turn.

Societies outside of the sections and complementary to them continue to grow around the Association. The meetings of the Society for the Promotion of Agriculture were lively and practical; those of the Geological Society were more technical in tone. The Entomological Club insisted on the extension and enlargement of the study of insects. An Ornithological Society was formed, and went at once to talking about birds. The Botanical Club held its eighth annual meeting. Prof. Britton, under instructions from the Toronto meeting, gave an account of the present state of systematic botany in North America. A National Chemical Society was projected.

The fact that this was the fiftieth meeting of the Association does not seem to have received special attention further than a mention in Prof. Mendenhall's address. The fact that the Association has maintained its vigor and has prospered during half a century is evidence that it has had a place of usefulness and has filled it. The question now arises whether, if it would meet the demands of the future as successfully as it has met those of the past, it will not have to adapt itself anew to the changed conditions of science and the country and to the present popular demand for scientific knowledge, which are very different now from what they were when it began.

The doors of the Association were thrown open to members of foreign societies, who will be admitted hereafter, with full privileges, without fees; and provision was made for inviting to the next meeting representations of the scientific societies of Mexico and Central and South America. The following officers were chosen for the ensuing year:

President.—Albert B. Prescott, Ann Arbor, Mich.

Vice-Presidents.—A, Mathematics and Astronomy—E. W. Hyde, Cincinnati, O. B, Physics—F. E. Nipher, St. Louis. C, Chemistry—R. C. Kedzie, Agricultural College, Michigan. D, Mechanical Science and Engineering—Thomas Grey, Terre Haute. E, Geology and Geography—J. J. Stevenson, New York. F, Biology—J. M. Coulter, Crawfordsville, Ind. H, Anthropology—Joseph Jastrow, Madison, Wis. I, Economic Science and Statistics—Edmund J. James, Philadelphia.

Permanent Secretary.—F. W. Putnam, Cambridge, Mass.

General Secretary.—Harvey W. Wiley, Washington, D. C.

Secretary of the Council.—A. W. Butler, Brookville, Ind.

Auditors.—Henry Wheatland, Salem, Mass.; Thomas Meehan, Germantown, Pa.

Treasurer.—William Lilly, Mauch Chunk, Pa.

The meeting for 1891 will be held in Washington, D. C.

LITERARY NOTICES.

THE EVOLUTION OF SEX. By PATRICK GEDDES and J. ARTHUR THOMSON. The Contemporary Science Series. New York: Scribner & Welford. Pp. 322. Price, $1.25.

THE purpose of the Contemporary Science Series is to bring within general reach of the English-speaking public the best that is known in all departments of modern scientific research. Frank investigations and clear presentations are promised, in particular, of all the questions of modern life—the various social and politico-economical problems of to-day, the most recent researches in the knowledge of man, the past and present experiences of the race, and the nature of its environment. The first book issued in this series covers a field in which lie some of the most difficult as well as most generally interesting of biological questions. The subject is, therefore, an attractive one both to trained biologists and to persons without special training, and the wants of both these classes of readers have had consideration in the mode of treating the subject which the authors have pursued. They undertake to give an outline of the various kinds of reproductive processes that occur in the animal kingdom, and to point out an interpretation of these processes in the elemental facts of biology. They have decided opinions on the important biological questions now in dispute, which are not always the ones generally accepted, and especially as regards the factors of organic evolution. Hence they are continually joining issue with this or that evolutionist or physiologist, agreeing only in part with any one. Darwin's theory of sexual selection comes up for criticism at the very outset, and both this and Wallace's views on natural selection are rated as accounting for the acquirement of secondary sexual characters only in part. The authors offer, as a broader and more fundamental explanation of the origin of sexual differences, that katabolic, or destructive, changes in living matter prevail in the male, while anabolic, or constructive, action characterizes the female. This idea as to the essential difference between the sexes is the key to the whole theory of sex relations held by the authors. Thus, in regard to what determines sex in the embryo, concerning which over five hundred theories have been set forth, they say that anabolic, or favorable, conditions of the environment tend to cause the production of females, while katabolic, or severe, surroundings favor the appearance of males. A considerable division of the volume is devoted to a description of the organs, tissues, and cells concerned in reproduction, in the course of which an account is given of the phenomena of hermaphroditism. In concluding this section the theory of sex already alluded to is fully set forth. The various modes of reproduction which obtain in the animal kingdom are then described, including parthenogenesis, which leads to a discussion of the alternation of one-sexed and two-sexed generations. The theory of reproduction which the authors advance is that there is a continual see-saw between anabolism and katabolism, nutrition and reproduction. Growth of cell and of organism alike has a limit which, as stated by Spencer, depends on the tendency of increase of mass to outrun increase of surface. When anabolism threatens to pass this limit, katabolism acts and restores the preponderance of surface. Reproduction is continually going on in organic

nature, because on the whole the katabolic conditions of the environment preponderate over the anabolic. In conclusion, certain psychological and sociological aspects of sex relations are discussed, namely, the occurrence of the love of mates and of offspring among animals, the intellectual and emotional differences between the sexes, and the various proposals for checking increase of population. The authors express strong aversion, based on biological grounds, to the recent attempts of some women to mold their sex into the fashion of men. They hold that the difference between the mental capabilities of women and men is highly beneficial to the race, and is hence to be fostered and not obliterated. Each chapter of the work is followed by a summary of its main points, and a list of books bearing upon the special topic under treatment. The authors have discussed the recently published views of Prof. Weisman on Heredity, and have taken account also of Wallace's latest criticisms on Darwinism. They express regret that limits of space have made it impossible to give the botanical side of their subject its proportionate share of attention, but they have inserted illustrations of the essential facts, which they deem sufficient to show the parallelism of the reproductive processes throughout nature. A defect of the book is in its language, which is frequently so involved as to be obscure, and is still oftener awkward. The volume is illustrated and has an index.

THE METALLURGY OF STEEL. By HENRY MARION HOWE. Vol. I. New York: The Scientific Publishing Company. Pp. 380, quarto. Price, $10.

IN this work metallurgists are provided with an account of the most important of metallurgical industries on a scale which is seldom ventured upon. Its purpose is to describe the present practice of steel-making in America without attempting to give the history of the industry. Hence the author says: "In describing old experiments and abandoned processes, I have not aimed to give matter of historic interest, but rather that which might be useful, whether in deterring others from repeating unnecessary or hopeless experiments, or in guiding them should processes once unsuccessful become commercially possible through changed conditions." Most of the first half of this volume is devoted to the characters of different steels, produced by admixtures of carbon, silicon, manganese, and other metallic and non-metallic elements. In considering the effect of carbon on iron, the author presents both the chemical and the microscopical evidence which goes to show that there are two conditions of combination of carbon with iron. In one of the early chapters the processes of hardening, tempering, and annealing are described, and the changes produced in the metal by these operations are explained. The absorption of gases by iron and their escape from the metal, and the various means taken to prevent the consequent forming of blow-holes and pipes, form a division of the subject that receives full discussion. The author considers next the varieties of stucture shown by the microscope, and the changes of crystallization, etc., produced by various treatments of the metal. The operations included under cold working and hot working are then described, after which the making of steel is taken up. A great many varieties of the direct process, several charcoal-hearth processes, and the crucible process are described and their results are compared. The closing chapter is a description of the apparatus for the Bessemer process, including a variety of modifications. The material of this volume has been published in supplements to The Engineering and Mining Journal within the past two years, during which time new results have been attained in some departments of the subject. Some of these—namely, on manganese steel and other special steels, on anti-rust coatings, and on lead-quenching—are added in appendixes. In stating the cost of metallurgical processes, the author has generally given the quantities of material and the amount of labor needed for a given work rather than the expense in dollars and cents, for the reasons that the former fluctuate less than the latter, and more managers are willing to tell what quantities of materials they use than what is their exact cost of production. He has inserted a great many references to original authorities, for the purpose of showing that his statements have a solid foundation, or so that the reader may examine any special topic more in detail. In re-

gard to his use of material already published the author says: "Such a work as this can not, of course, be carried out without much compilation; but by far the greater part of the labor has been expended in the original work of discussing the data thus compiled, and in acquiring wholly new data, whether by experimental research or in prolonged examination of the processes described. For instance, there are about two hundred tables in this volume; of these, all but about twenty (and most of these twenty are very small) are either wholly original or consist mainly or wholly, not of matter published by others, but of numbers calculated therefrom." As to revealing trade secrets, his rule has been to give all the information about present practice that seems useful and that he has permission to give, while trying to conceal the identity of the establishment at which it exists. This volume being numbered one, implies another or more to follow it, but no announcement of succeeding volumes is made in the one now issued.

REPORT UPON UNITED STATES GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN, in charge of Captain GEORGE M. WHEELER. Vol. I, Geographical Report. Washington. Pp. 780, quarto, with Plates and Maps.

THIS report was practically completed in June, 1879, but the officer in charge was prevented, by a press of other duties and by subsequent prolonged illness, from presenting it for publication until 1887. The series of expeditions covered by the report was made under the direction of the Chief of Engineers, United States Army, in 1869, and in successive years from 1871 to 1879, inclusive. On the organization of the Geological Survey in 1879, surveys by the War Department for military and industrial purposes were discontinued. The results obtained in these expeditions were published in eight quarto volumes, each devoted to a special topic, as astronomy, geology, etc. The present volume gives a brief account of the expedition of each year, with a summary of results. In 1871 a party explored the Grand Cañon of the Colorado River in boats, from Camp Mohave to Diamond Creek. An itinerary of this trip is given, to which is prefixed a sketch of earlier explorations along this river. Some account is given of the population, industries, irrigation, and land classification in the regions explored, which include parts of New Mexico, Arizona, California, Nevada, Utah, Colorado, Idaho, and Oregon. In several appendixes are given descriptions of the atlas sheets issued as a part of these reports, an account of the methods of survey employed, notes on the survey and disposal of the public lands of the United States (with map), and considerations on the government land and marine surveys of foreign nations. The last appendix is a memoir on discoveries and explorations on the Pacific Coast of North America and in the interior west of the Mississippi from 1500 to 1880. In the first part of the memoir the explorations between 1500 and 1800 are mentioned, and eleven curious old maps are reproduced which show the very imperfect knowledge of America that existed during much of this period. This is followed by an epitome of the memoir by Lieutenant G. K. Warren, made in 1858, on the explorations west of the Mississippi from 1800 to 1857, and by a sketch of the explorations and surveys from 1857 to 1880. The volume contains three folded maps and thirty-eight plates, the latter including the eleven old maps already mentioned, and representing also typical localities, contours, Indian costumes, etc., in the country examined.

PHYSIOGNOMY AND EXPRESSION. By Prof. PAOLO MANTEGAZZA. The Contemporary Science Series. New York: Scribner & Welford. Pp. 327. Price, $1.25.

IN this treatise the author takes up the study of expression at the point where Darwin left it, "and modestly claims to have gone a step further." There is a great deal of chaff in the literature of the subject; and the author, who is one of its most accomplished students, has accordingly had the task set before him of separating once for all positive observations from the number of bad guesses and ingenious conjectures which have hitherto encumbered the study. His wish, he says, has been "to render to science what is due to science, and to imagination what is due to imagination." Besides new facts, the reader is invited to find in his work facts already known, but inter-

preted by new theories. A historical sketch of past studies and treatises on expression is given. Of authors of the old school, Lavater is found to have come the nearest to being scientific. The real science begins with Camper, from whom the famous facial angle took its name. But the great anatomists and physicists who preceded Darwin only touched one side of the problem—expression in its relation to art and the æsthetic. Darwin traced the general laws which govern expression in the whole animal kingdom; and in his book, published only in 1872, expression, in so far as it is a special branch of comparative biology, asserted itself as a new science. In the science of the present day we have, on one side, a study of the human countenance, which is associated with anatomy and anthropology, and, for its application, with all the plastic sciences; and, on the other side, a study of expression, and of expression in relation to psychology, to comparative ethnology, "the applications of which interest in turn painter, sculptor, and actor." The present book proposes "modestly to restore to anthropology and to psychology what belongs to either, and to make known the positive documents which we possess to-day on the human countenance and on expression." Two diverse and important functions are accorded to physical expression—it may replace or complete language, and it may defend the nerve-centers and other parts of the body against dangers of different kinds. Including all living beings in a general view, we may, according to the author, say that the expression of emotion augments in intensity and variety as the animal rises to a higher scale and becomes more sociable. These two maxims concerning the office and the development of expression, which we have selected from the observations in the chapter on the Language of Expression, indicate the importance and interest of the study. The first part of the treatise is devoted to the human face, its several features, and its comparative morphology; the second part to the expression of the emotions, in which, besides what are usually understood under that term, are included the minor emotions or feelings, the expression of thought, the general expressions of repose and action, disquietude, etc., and racial and professional expression, with additional chapters on the moderators and disturbers of expression, criteria for the determination of the strength of an emotion by the degree of expression, for judging the moral worth of a physiognomy and the intellectual value of a face, and on the physiognomy of gestures and the expression of clothes. While the scientific is predominant in the method of the book, a kind of literary discursiveness is frequently indulged in which supplies pleasant reading supplementary to the solid principles of the bulk of the text.

GEOLOGICAL SURVEY OF NEW JERSEY. ANNUAL REPORT OF THE STATE GEOLOGIST FOR 1889. Pp. 112.—FINAL REPORT OF THE STATE GEOLOGIST. Vol. II, Part I. Pp. 642. New Brunswick: Irving S. Upson, Assistant in charge of the Office.

THE survey was continued through 1889 on the lines planned by Dr. Cook before his death, which occurred on the 22d of September. A leading object in the work has been, as heretofore, to develop and make public the natural products and resources of the State. The present volume bears evidence, continuing and additional to that given in previous volumes, of the success with which this object has been met. The geodetic survey was continued during the year, after having been suspended in 1888, southerly and westerly from the line—Hammerton-Newfield—which was reached in 1887. In a section on the archæan rocks, Mr. Frank L. Nason gives a historical review of what has been done in the Archæan Highlands since 1836; and continues with a report of the field-work of the year, descriptions of the type rocks of the region and their distribution, studies of the economic value of rocks, and special notes on the zircon and molybdenite found there. The section on Water-Supply and Artesian Wells, by Mr. C. C. Vermeule, includes accounts of the measures which have been taken to secure a water-supply to several cities and towns, and notes of the observations made in boring nearly thirty artesian wells in different parts of the State. The borings of a well at Atlantic City, to a depth of about 1,400 feet, show that the Quaternary gravels and sands are over 200 feet thick, and the strata under them to 1,225 feet are Miocene, while below that depth no fossil is yet found distinctive

of the Eocene. The second volume of the Final Report is devoted to the mineralogy, botany, and zoölogy of the State; the first part comprising the mineralogy and botany. The minerals—for which, by reason of the great number of species and varieties, their rare chemical combinations, and their wonderful crystalline development, the localities of New Jersey are famous—are catalogued by Mr. Frederick A. Canfield, with the aid of the best collections. The Flora of the State is divided by Dr. N. L. Britton, who furnishes the catalogue, into a northern and a southern, the division between which is approximately indicated by the glacial moraine. A minor division includes the marine and coast group of plants, species, and varieties especially characteristic of the sea-beaches and salt or brackish marshes and meadows; and a fourth group is made of species of especial western distribution, which, however, have no special significance in the consideration of the origin of the flora. In all, 5,641 species and varieties of plants are catalogued.

WHEELBARROW: Articles and Discussions on the Labor Question. Chicago: The Open Court Publishing Company. Pp. 303. Price, $1.

"WHEELBARROW" appears to be both the title of this book and the pen-name of the author. The volume is made up of articles contributed to The Open Court over this signature, containing also two by Lyman J. Gage, written in controversy with "Wheelbarrow" over The Ethics of the Board of Trade. The articles are intended to present various topics of the labor question from the standpoint of a common laborer, which was the author's position in early life. His autobiography prefixed to the volume informs us, however, that he rose from the occupation of wheeling gravel on railways through the grades of country school-teacher and brickyard laborer to that of lawyer. He served in the army during the war with Mexico and the civil war, and attained the rank of brigadier-general, and we understand that he is General M. M. Trumbull, of Chicago. His portrait is inserted as a frontispiece to the book. The tone of the "Wheelbarrow" essays is against the revolutionary schemes of some who call themselves workingmen, and in favor of a manly independence and a generous fraternity on the part of laborers, in their relations with their employers and with each other. On the money question he argues for a hundred cents' worth of silver in the silver dollar; he opposes Henry George's single-tax idea; and he charges the produce brokers with "making bread dear." The volume contains also three essays on The Poets of Liberty and Labor, namely, Gerald Massey, Robert Burns, and Thomas Hood. The articles are written in simple and picturesque language, and the views they contain are enforced by many anecdotes and fables.

EVOLUTION AND DISEASE. By J. BLAND SUTTON. The Contemporary Science Series. New York: Scribner & Welford. Pp. 285. Price, $1.25.

THE author's purpose in writing this book has been to indicate that there is a natural history of disease as well as of plants and animals. It is difficult to define disease when our remarks are restricted to the human family; and it becomes obviously more difficult when we attempt it, as the author has done, on a broad zoölogical basis. It necessarily follows, he assumes, from the relations between man and the higher animals, "that there should be a similarity in the structural alterations induced by diseased conditions in all kinds of animals, allowing, of course, for the differences in environment. This we know to be the case, and it is clear that as there has been a gradual evolution of complex from simple organisms, it necessarily follows that the principles of evolution ought to apply to diseased conditions if they hold good for the normal or healthy states of organisms; in plain words, there has been an evolution of disease *pari passu* with evolution of animal forms." In view of the talk of physiological types of diseased tissues, the author's earlier efforts were directed to searching among animals for the purpose of detecting in them the occurrence of tissues which in man are found only under abnormal conditions. The hypothesis proved to be true in only a limited sense; but, "at the same time, the truth of an opinion held by nearly all thoughtful physicians—that disease may in many instances be regarded as exaggerated function—was forci-

bly illustrated, and I quickly saw that the manifestations of disease were regulated by the same laws which govern physiological processes in general, and that many conditions regarded as pathological in one animal are natural in another." This view is enforced in the successive chapters of the book, in which—according to the author's plan of treatment as summarized by himself—the effects of increased use and disuse of parts are considered in connection with the gradual change in function of organs, and the part played by transmission of the effects of increased use and disuse in producing vestigial structures in complex organisms. The tendency of vestigial structures to become diseased, or to give rise to conditions disadvantageous to the individual, is dealt with. The transmission of acquired characters and malformations is discussed. Causes of disease arising without the organism, and the relations they bear to inflammation and fever, are given a chapter. Tumors are considered in connection with general morbid processes, and the scanty knowledge we possess of the zoölogical distribution of disease is summarized. The illustrations of the principles have been selected, whenever it was practicable, from animals other than man, for the author believes that man has been studied too exclusively.

LONGMANS' SCHOOL GEOGRAPHY FOR NORTH AMERICA. By GEORGE G. CHISHOLM and C. H. LEETE. New York: Longmans, Green & Co. Pp. 384. Price, $1.25.

THE first feature of this work to be noticed is its departure from the familiar thin quarto form in which geographies that combine maps and text are made. This volume contains only text and illustrations, and is intended to accompany an atlas. An examination of it will not proceed far before showing that it differs from the ordinary geography in something more important than form. The book aims to set before the pupil those facts of geography that are most worth his knowing, and that are most effective as discipline. Hence all countries are not described in conformity with a rigid outline, but the characteristic features of each are given especial prominence. The authors have sought to make the study of geography something better than a memorizing process by bringing out the relations of cause and effect. To aid in this latter purpose, the general laws of physical geography are stated in an introduction, and to this chapter are referred the facts that especially illustrate the laws. Cause and effect are particularly developed in the paragraphs on towns, where it has been sought to show why and on what basis a town exists in any particular place. In the description of the natural features of a region, little regard is paid to the artificial boundaries of political divisions and subdivisions. Thus, in the treatment of North America, which is preceded by a sketch of North and South America together, each of the general topics, surface, climate, life, etc., is dealt with for the whole continent, the portion of each of these features that becomes the share of one or another country being pointed out later. In this way are avoided the many repetitions that would be involved in describing separately the geographical characters of the fifty States and Territories of the United States. The facts relating to the products and commerce of a country are also presented from a national standpoint, and comparisons are made with foreign countries. The work is not confined to North America, as might be inferred from a hasty reading of the title; the other grand divisions of the globe are treated with more or less fullness according to their importance to the American pupil. The text is illustrated by seventy well-selected cuts, but unfortunately the pictures have such a muddy appearance that their value is much impaired. In spelling foreign names the authors have followed the rules adopted by the Council of the Royal Geographical Society. The volume is closely printed, and hence contains a great deal of matter within a moderate compass, and different sizes and styles of type, cross-references, foot-notes, and statistical tables have been made use of to link the various descriptions into one connected whole.

A MANUAL OF ANATOMY FOR SENIOR STUDENTS. By EDMUND OWEN, M.B., F.R.C.S. London and New York: Longmans, Green & Co. Pp. 526. Price, $3.50.

FROM its title alone one might infer that this work had about the same scope as others on the same subject prepared for medical students, but it has a somewhat peculiar character, owing partly to what it

omits and partly to what it takes in. The author says in his preface: "Most of the ground has, I am aware, been already covered, especially as regards so-called surgical anatomy. But the entire range of anatomy has not hitherto, I think, been treated from the point of view of the senior student, who, having quitted the dissecting-room, is in need of a volume which shall supply him with such anatomical information, free of wearying detail, as is essential for his successful and intelligent work in the medical and surgical wards and in the special departments of his hospital." He also says: "Having always found it impracticable to draw a hard-and-fast line between facts which bear upon the science of medicine and those which chiefly concern the practical surgeon, I, a surgeon, have presumed in this Manual boldly to trespass upon the domains of the physician, as well as of the specialist." This fact makes the book better calculated to be of use to American students than it otherwise would be, for the medical profession and the public in this country have likewise found it "impracticable to draw a hard-and-fast line" between physicians and surgeons such as exists in England. Accordingly, there is less minute description of parts than in manuals for the dissecting-room, while malformations and disorders, and the operations which these call for, are described more fully than is usual except in the most complete treatises. The style of the book is clear and concise, the text is liberally illustrated, and the mechanical work of the volume is excellent.

HEAT AS A FORM OF ENERGY. By Prof. ROBERT H. THURSTON. Boston: Houghton, Mifflin & Co. Pp. 261. Price, $1.25.

PROF. THURSTON has produced a book for the general reader rather than a text-book for the student. It traces the development of the science of heat from the speculations of the ancient philosophers down to the results of the latest experiments. After stating the ideas of the philosophers in regard to heat, the author gives an outline of the modern science of thermodynamics. In the next chapter he shows how the transfer of heat in various ways is an essential feature in many of the world's important industries, and in many great operations of nature. Most of the latter half of the volume is devoted to the development of heat-engines —machines for transforming heat into mechanical energy. The author is evidently in a favorite field when describing the development of the steam-engine, for he devotes considerable space to this topic, and illustrates the account with pictures of several successive forms of engines. The book is the third of the Riverside Science Series.

The explorations by the United States Fish Commission steamer Albatross during the year 1889 covered a considerable extent of mainland and inland coast waters from California south of Point Conception to Washington. The new discoveries of fishes along the shores of California, Oregon, and Washington were almost wholly from greater depths than fifty fathoms. Of the sixty species of fishes obtained from the Revillagigedos Islands, only about a dozen had been previously recorded there; not more than half were yet known from the mainland; and the other half included new forms and shapes from the islands of the western Pacific and from the Galapagos. The collections from the Gulf of California were obtained mainly along the shores and in the shallower waters of its northern portion. The deeper waters of the Gulf have a bottom of blue mud singularly barren of life. The *Preliminary Report* of Mr. *Charles H. Gilbert* on the fishes collected by the steamer contains descriptions of ninety-two species—all new. *The New Fishes collected off the Coast of Alaska and the Adjacent Region to the Southward* is the subject of a paper by Mr. *Tarleton H. Bean*. Eight of the genera are among the common forms of the Atlantic, and four of them are apparently new to science. Other papers to which the scientific results of the explorations of the Albatross have given rise are a *Catalogue of Fishes collected at Port Castine, St. Lucia*, by *David Starr Jordan*, and a *Catalogue of Skeletons of Birds* collected at points along the South American coast, by *Frederic A. Lucas*. All are published by the United States National Museum.

A description of *Etheostoma tippecanoe, a New Species of Fish from Tippecanoe River, Indiana*, is described by *David Starr Jordan* and *Barton Warren Evermann*, and figured

in the Proceedings of the National Museum, Washington.

The *Bulletin from the Laboratories of Natural History of the State University of Iowa*, Nos. 3 and 4, contains six papers—viz., Some New Species of Palæozoic Fossils, by S. Calvin; The Saprophytic Fungi of Eastern Iowa, and Common Species of Edible Fungi, by T. H. McBride; The Loess and its Fossils, and A New Species of Fresh-Water Mollusk, by B. Shimer; and the Pselaphidæ of North America, by Dr. E. Brendel and H. F. Wickham. Published by authority of the Regents, at Iowa City.

Among the latest papers left by Prof. *Leo Lesquereux* is one *On Some Fossil Remains considered as Peculiar Kinds of Plants*, which appears as one of the publications of the United States National Museum. It relates to some fossils, one of which, from the Upper Helderberg limestone, Sandusky, Ohio, is like a long, flexuous, tubular stem imbedded in a large piece of compact gray limestone. The others, from the Erie shale near Cleveland, are cylindrical fragments traced in relief upon gray, hard, yellowish, sandy shale, or else short, oval, utricular bodies, rounded at one end, bilobate at the other, found on large flattened pebbles or lenticular masses of argillaceous iron ore, locally distributed in the shale. The author named the fossils *Halymenites Herzeri*, *Cylindrites striatus*, and *Physophycus bilobatus*—all new species.

Prof. *A. H. Mackay* publishes, as a reprint from the Transactions of the Royal Society of Canada, a paper on the *Fresh-Water Sponges of Canada and Newfoundland*. It is intended to be only a synopsis, just sufficient to indicate the extent to which the Spongillidæ of the Dominion have been observed, and to facilitate further investigation. After the introductory general observations on the Spongillidæ, ten species are described, of which *Heteromeyenia pictovensis*, of different lakes in Nova Scotia and Newfoundland, is declared to be the firmest and most beautiful of all the fresh-water sponges in Canada.

The Catalogue of Minerals for Sale by George L. English & Co., Philadelphia (William Niven, New York), fifteenth edition, June, 1890, is a hand-book and bulletin in mineralogy as well as a dealers' list. Besides the ordinary catalogue matter, it contains forty pages of accounts, with illustrated descriptions, of new minerals. The catalogue matter itself is of scientific value, for it includes a complete classified list of all the species described in Dana's System and in the appendixes and the more recent accounts in the American Journal of Science. The pleasant information is given that the present elaborate catalogue is the result of a very great increase in the demand for mineral specimens.

A new theory of *The Origin of Polar Motion* is put forward by *M. Myerovitch*, who attempts to prove that the motion arises from the repulsive power of molecules. The author has published the introduction of his contemplated book on the subject in advance of the book itself, for the information of critics. Rosenberg Brothers, 266 West Twelfth Street, Chicago, Ill.

Zoe, a monthly Biological Journal (Zoe Publishing Company, San Francisco), is filled with contributions of natural-history notes incident and pertinent to the West and the Pacific slope. In a recent number, Mr. Behr's paper on the Economy of Nature as Exemplified by Parasites gives illustrations of the danger of reckless interference with the natural order of affairs. President Jordan accounts for some apparent anomalies in the Distribution of Fishes in the Yellowstone Park. Mr. T. S. Brandegee has some observations on the alternate defoliation and new leafing of *Fouquieria* several times in the season, according to changes in the moisture conditions—a fact that is not unknown with some species on the Atlantic slope. Mr. H. R. Taylor describes some curious incidents of individuality in the nesting habits of the golden eagle.

Among the eight papers in the fifth and sixth numbers of *Studies in the Biological Laboratory of Johns Hopkins University*, Vol. IV, *H. Newell Martin* and *W. K. Brooks*, editors, we notice as of more obvious general interest those of Prof. Martin and Julius Friedenwald on the Effect of Light on the Production of Carbon Dioxide by Frogs; of J. C. Hemmeter on the Effects of Certain Members of the Ethylic Alcohol Series on the Isolated Mammalian Heart; of Prof. Martin and E. C. Applegarth on the

Temperature Limits of the Vitality of the Mammalian Heart; and of S. Watase on the Morphology of the Compound Eye of Arthropods. The articles requiring it are amply and excellently illustrated.

The Journal of Morphology, No. 3, Vol. III, of which *C. O. Whitman* and *W. Phelps Allis* are editors, has four articles—viz.: on the Embryology of the Earthworm, by Edmund B. Wilson; the Ribs and Median Fins in Fishes, and The Morphology of the Vertebrate Skull, by Dr. C. Baur; and a discussion, by Dr. R. W. Shufeldt, of the position of Chamæa (the wren-tit) in the system. They are well illustrated.

Dr. *Michael Foster*, in conducting *The Journal of Physiology*, enjoys the assistance of two English co-operators and of Prof. *H. P. Bowditch*, Prof. *H. Newell Martin*, and Prof. *H. C. Wood*, in the United States. Numbers 1, 2, and 3 of Vol. XI contain thirteen articles relating to bodily temperature, respiration, salivary secretion, the digestive system, the blood, phonation, the nervous system, and knee-jerk. Cambridge, England.

The quarterly *University Studies*, published by the University of Nebraska, for July, 1890, *L. A. Sherman*, editor, contains papers on the Determination of Specific Heat and of Latent Heat of Vaporization with the Vapor Calorimeter, by Harold N. Allen; the Color Vocabulary of Children, by Harry K. Wolfe; and the Development of the King's Peace and the English Local Peace-Magistracy, by George E. Howard. The last is also published separately. In it the author, who is Professor of History in the University, traces the idea of the public peace of the community from the beginning to the re-establishment of popular self-government in the English shire by the act of Parliament of August 13, 1888.

The quarterly *Bulletin of the National Association of Wool Manufacturers* for June, 1890, *S. N. Dexter North*, editor, is devoted chiefly to questions concerning the pending Tariff Bill and its effect on woolens. An article not coming under this description is a History of Wool-combing in England.

It appears from the *Calendar of the Faculty of Medicine of McGill University, Montreal*, that the session of 1890 will be its fifty-eighth, the medical school having been founded in 1824 and suspended during the political troubles from 1836 to 1839. The new building has been found admirably adapted for making the teaching of the primary branches practical and thorough. The session is from October 1st to April, with a summer session of twelve weeks from the middle of April. The school was attended last year by 261 students.

The first number of the first volume of the *Quarterly Review of the United Brethren in Christ*, which is intended to represent the thought of the growing religious denomination of that name, *J. W. Etter*, D. D., editor, appeared in January, 1890. While its articles are intended to and do appeal chiefly to churchmen, we notice as of general interest that of the Rev. J. H. Pershing on the Conemaugh Cataclysm; and as claiming the attention of those who wish to be acquainted with various sides of thought, that of Prof. J. P. Landis on Some Foes of Christianity. The foes described in this article are Pantheism, Materialism, Agnosticism, Rationalism, and Socialism, which are grouped as "anti-theistic theories."

In a paper read by Dr. *G. Brown Goode* before the American Historical Association, on *Museum History and Museums of History*, a historical review is followed by a statement of the author's ideas of what a museum should contain, what purposes it should be intended to serve, and how it should be arranged and managed. The same author's address on the *Origin of the National Scientific and Educational Institutions of the United States* gives a connected view of the growth of such institutions from their beginning in the attempt of Mr. Boyle, Bishop Wilkins, and others to establish in the colony of Connecticut a society for promoting knowledge. A third address by Dr. Goode was delivered before the American Philosophical Society, at the commemoration of the one hundredth anniversary of the death of Benjamin Franklin, and is on his *Literary Labors*. In it Dr Franklin is presented as one who, although standing prominently forth as the only great literary man of America in colonial days and the first fifty years of the Republic, had no thought of obtaining for himself literary fame, but made use of what he gained to promote the welfare of his country.

Prof. *William Watson Goodwin's Syntax of the Moods and Tenses of the Greek Verb* appears from the press of Ginn & Co. in a new edition, rewritten and enlarged from the editions of 1860 and 1865, and so modified by the operation of the author's own criticisms of his earlier effort as to have become to a great extent a new and independent work. A great change has in fact come over the conditions of Greek scholarship during the interval, so that it could hardly be adequately represented in its present state without reconstructing the exposition almost from the beginning. As the author remarks, "few are aware how modern are many of the grammatical doctrines which are now taught in all classical schools." The writings of the Greek authors are full of refinements of style and delicate distinctions which greatly impede the progress of the beginner and make the labor of the advanced student not easy, and on which the ordinary grammars and lexicons cast but a dim light. The purpose of Mr. Goodwin's manual, if we gather it correctly, is systematically to use the full light of the most recent scholarship in explaining them.

The Directional Calculus of Prof. *E. W. Hyde* (Ginn & Co.) is an effort to introduce the system of multiple algebra invented by Hermann Grassmann, and called by him the Theory of Extension. The author has become convinced of the superiority of Grassmann's system to Hamilton's quaternions, in that it is founded upon and is consistent with the idea of geometric dimensions; and that in it all geometric quantities appear as independent units. His directional methods are also believed to be superior to the comparatively awkward and roundabout methods of the Cartesian co-ordinates. While Grassmann's results are all obtained for *n*- dimensional space, Prof. Hyde has, for greater simplicity, restricted the discussion to space of two and three dimensions.

The purpose of Mr. *William Roscoe Thayer's The Best Elizabethan Plays* (Ginn & Co.) is to present specimens of the work of the five Elizabethan dramatists who stand highest among Shakespeare's contemporaries. The selected works are Marlowe's Jew of Malta, Ben Jonson's The Alchemist, Beaumont and Fletcher's Philaster, Fletcher and Shakespeare's Two Noble Kinsmen, and John Webst
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and purposes of Jesus, and that this idea is manifested in his narrative; hence that the Christian church has been divided on these subjects from the very beginning.

Mr. *George W. Childs* publishes a booklet, small enough for the pocket and large enough to serve for an evening's reading, of *Recollections of General Grant*, with an account of the presentation of the portraits of Generals Grant, Sherman, and Sheridan at the Military Academy, West Point. (Collins Printing House, Philadelphia.)

The *Annual Report of the State Board of Charities* (New York) for 1889, besides the general account of the charitable institutions of the State, comprises special reports of the investigation of the Rochester Orphan Asylum; on reformatories; on the deaf and dumb; on the State Soldiers' and Sailors' Home; on dependent children; and on the condition of children in asylums.

PUBLICATIONS RECEIVED.

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American Book Company, New York. Health for Little Folks (Authorized Physiology Series). Pp. 121.

Ballou, William R., M. D. A Compend of Equine Anatomy and Physiology. Philadelphia: P. Blakiston, Son & Co. Pp. 205. $1.

Baruch, Simon, M. D., New York. The Relation of Peripheral Irritation to Disease. Pp. 17.

Burr, George L. The Literature of Witchcraft. New York: G. P. Putnam's Sons. Pp. 66.

Carus, Paul. The Ethical Problem. Chicago: Open Court Publishing Company. Pp. 99. Cloth, 50 cents.

Census Office, Washington. Bulletin on the Production of Slate. Pp. 10.

Chittenden, Rev. E. P. The Pleroma: a Poem of the Christ. New York: G. P. Putnam's Sons. Pp. 347. $2.50.

Day, David T. Mineral Resources of the United States. Report for 1888. Washington: Government Printing-Office. Pp. 652.

Ellis, Havelock. The Criminal. New York: Scribner & Welford. Pp. 337. $1.25.

Fraser, Persifor, Philadelphia. Persistence of Plant and Animal Life. Pp. 12.

Graham, Douglas, M. D. A Treatise on Massage. New York: J. H. Vail & Co. Pp. 342. $2.75.

Greely, A. W. Annual Report of the Chief Signal Officer, United States Army. Washington: Government Printing-Office. 2 volumes. Pp. 389 and 165.

Hale, Edward M., M. D. Toxic, Pathogenetic, and Therapeutic Properties of the Cactacea. Pp. 11.

Halsted, Byron D. Some Fungous Diseases of the Spinach. Pp. 15.

Hardy, Arthur Sherburne. Elements of the Differential and Integral Calculus. Boston: Ginn & Co. Pp. 239. $1.65.

Hazen, H. A. The Tornado. New York: N. D. C. Hodges. Pp. 143. $1.

Hill, Robert T. The Cretaceous Rocks of Texas, and their Economic Value. Austin. Pp. 36.

Holyoake, G. J. What would follow on the Effacement of Christianity. Buffalo, N. Y.: H. L. Green. Pp. 15. 10 cents.

Howard, George E., Lincoln, Neb. Evolution of the University. Pp. 36.

Illinois Agricultural Experiment Station. Investigation of Milk Tests. Pp. 8.—Experiments with Wheat. Pp. 16.

Ingersoll, Robert G. The Gods. Buffalo: H. L. Green. Pp. 40. 10 cents.

James, J. F., Philadelphia. On Variation. Pp. 16.

Kedzie, R. C. Fertilizer Analyses. Michigan State Agricultural College. Pp. 11.

Kennedy, John. A Stem Dictionary of the English Language. New York and Chicago: A. S. Barnes & Co. Pp. 282.

Kimball, S. I. Organization, etc., of the United States Life-Saving Service. Washington: Government Printing-Office. Pp. 33.

Lamborn, Robert H., Editor. Prize Essays on Dragon-flies *vs.* Mosquitoes. New York: D. Appleton & Co. Pp. 202, with Plates. $1.50.

Lathrop, C. C. A Secret Institution. New York: Bryant Publishing Company. Pp. 389. 50 cents.

Leffmann, Henry. A Compend of Chemistry. Philadelphia: P. Blakiston, Son & Co. Pp. 193. $1.

Lewis, T. H. Stone Monuments in Iowa and Minnesota. Pp. 6.

Lighthall, W. D. Spiritualized Happiness Theory. Montreal. Pp. 22.

Litchfield, Mary E. The Nine Worlds. From Norse Mythology. Boston: Ginn & Co. Pp. 163. 60 cents.

McAdie, A. Tornadoes. Pp. 14.

McCook, H. C. American Spiders and their Spinning Work. Vol. II. Philadelphia: Academy of Natural Sciences. Pp. 478.

Minnesota, Public Health in, Monthly Reports of the State Board of Health. Red Wing. Pp. 8.

Montgomery, Henry. Aboriginal Monuments in North Dakota. Pp. 4.

Müller, F. Max. Three Lectures on the Science of Language. Chicago: Open Court Publishing Company. Pp. 112. 75 cents.

New England Meteorological Society. Monthly Bulletins. Pp. 8.

New York Agricultural Experiment Station. Bulletins Nos. 21 and 22. Pp. 48 and 12.

National Geographic Magazine. Vol. II. Nos. 3 and 4. Washington: National Geographic Society. Pp. 60 and 55.

Ohio Agricultural Experiment Station. Bulletin on Food for Milk Production. Pp. 24.—Bulletin, Technical Series. No. 2. Pp. 100, with Plate.

Packard, A. S. Life History of Drepana Arcuata: Evolution of Bristles, etc., of Caterpillars. Pp. 80, with Plates.

Photo-Gravure Company, New York. Sun and Shade. June and July, 1890. 16 Plates. 40 cents each number. $4 a year.

Poor, H. V. and H. W., New York. Introduction to Poor's Manual of Railroads for 1890. Pp. 16, with Map.

Preston, Thomas. The Theory of Light. New York: Macmillan & Co. Pp. 465. $3.25.

Shufeldt, R. W. Osteology of Arctic and Subarctic Water-Birds. Part VII. Pp. 24.

Silver Committee, National Executive. First Report. Washington. Pp. 10.

Smith, Edgar F. Electro-Chemical Analysis. Philadelphia: P. Blakiston, Son & Co. Pp. 116. $1.

Storrs Agricultural Experiment Station, Connecticut. Second Annual Report. Pp. 183.

Taft, L. R., Lansing, Michigan. Greenhouse Construction and Heating. Pp. 27.

Thruston, G. P. The Antiquities of Tennessee. Cincinnati: Robert Clarke & Co. Pp. 362. $4.

Tratman, E. E. Russell, C. E. Report on the Substitution of Wood for Metal in Railroad Ties. Washington: Government Printing-Office. Pp. 363.

United States Coast and Geodetic Survey. Monthly Chart Corrections. Pp. 6.

Waring, George E., Jr. The Sewerage of Columbus, Ohio. Pp. 24.

Woody, S. E. The Essentials of Medical Chemistry. Philadelphia: P. Blakiston, Son & Co. Pp. 157.

POPULAR MISCELLANY.

California and its Mines.—The trustees of the California State Mining Bureau find in the increasing demands for their report evidence that the institution is fulfilling a public want and is growing in public favor. The edition of the sixth annual report is exhausted, and that of the seventh nearly so, while the edition of the eighth was nearly doubled. A historical fact of much significance is embodied in the statement that while in the early days the newspapers of the State teemed with notices of mining interests which were summarized at regular intervals in quarterly and annual reviews, the articles of that kind have been gradually curtailed as the relative importance of the mines diminished and other interests pushed themselves into prominence, till now they appear, if at all, as mere items. Hence the Mining Bureau has become the only center and the best source of information on the subject. A complete review of the mines and mining operations was given for the first time in the report for 1888. The report for 1889 assumes that the whole country owes very much of its prosperity to mining. Every State owes that industry something; the mid-continental regions almost their very existence. Mining investments are among the most profitable, notwithstanding an impression to the contrary prevails. The impression that the gold-mines of California are depleted below the point of profitable production is likewise mistaken. The gold taken out has exhausted but little of the auriferous wealth of the State, and the annual production has not heretofore much exceeded what it may be reasonably hoped to reach and maintain in the future. Besides its gold-fields and silver-bearing lodes, California possesses the more common metals and minerals in great variety. There is hardly a county in the State but has valuable mineral deposits of one kind or another, and the distribution of these products is pronounced remarkable. Fourteen of the fifty-three counties make a notable production of gold, and twelve of gold and silver; five produce quicksilver, two borax, two salt, four asphaltum, two petroleum, three copper, etc. Were California even poor in the precious metals, it would yet become a great mining State. It is asserted in the report that gold-mining has not yet reached even the stage of sturdy infancy.

Caprices of Soils.—The system of studying the adaptation of soils to crops has grown out of the failure of attempts to settle such questions in the laboratory. This work, as is shown in a Bulletin of the Ohio Experiment Station, is attended with great difficulties. "So great is the variation in natural fertility in soils that appear to the eye to be identical in composition, that the results of field experimentation are liable to be even more misleading than those of the laboratory. Take any single acre of ground for illustration. An open glade in the original forest may have permitted the wind to sweep away its winter coverlet of leaves, and they may have lodged in a thicket of underbrush adjoining, carrying stores of potash and phosphoric acid with them. Such a glade may have been for centuries the pasturing ground of deer. It would then accumulate nitrogen, but would lose potash and phosphoric acid through an additional channel, while the thicket would accumulate these in excess of nitrogen. The growth of a surface-rooting tree in one spot may have drawn upon the adjacent surface-soil for supplies of potash; that of a tree with a deep tap root in another may have drawn its support largely from deeper layers of the soil, and also have opened a way for drainage. A slight depression of the soil here may have received added fertility in the wash from a slight elevation there, and he who has studied the soil carefully, especially where its levels are shown by the melting of snow when the ground is frozen, will have detected irregularities of level unsuspected by the casual observer."

Firing Pottery Kilns by Gas.—A new method of firing kilns by gas has been introduced at one of the Trenton, New Jersey, potteries by the use of which the expense of baking the ware is greatly reduced. It is dependent on the principle of preheating the air before it enters the kiln, so that a perfect combustion is secured, with no loss of heat. Gas generated outside the building is forced through an underground flue to the center of the kiln, whence it is carried by branch channels to the several mouths around the side of the kiln. There it is combined with air, and combustion takes place. The heated air then passes upward, and, instead of escaping out of the chimney, it is drawn down a well-hole through the center of the kiln and passes down and around the channel at the base of the kiln in the opposite direction from that in which it entered, and to near where it entered. After some time the dampers are reversed, so that the cold air enters the channel through which the heated air from the kiln has been passing toward the chimney, and the heated air escapes by the opposite passage. The cold air is thus heated some 1,000 or 1,500 degrees by passing through the heated channel, with the saving of much heat that was formerly wasted by passing immediately out of the chimney. The dampers are reversed every half hour, whereby the cold air is at every turn passed through a freshly heated chamber.

Some Advantages of Wild Life.—The two great points of superiority of the native or savage soldier over the representative of civilized discipline, says Captain John G. Bourke, in his An Apache Campaign in the Sierra Madre, are his absolute knowledge of the country and his perfect ability to take care of himself at all times and under all circumstances. Though the rays of the sun pour down from the zenith, or the scorching sirocco blow from the south, the Apache scout trudges along as unconcerned as he was when the cold rain or snow of winter chilled his white comrade to the marrow. He finds food, and pretty good food too, where the Caucasian would starve. Knowing the habits of wild animals from his earliest youth, he can catch turkeys, quail, rabbits, doves, or field-mice, and perhaps a prairie dog or two, which will supply him with meat. For some reason he can not be induced to touch fish, and bacon or any other product of the hog is eaten only under duress; but the flesh of a horse, mule, or jackass, which has dropped exhausted on the march and been left to die on the trail, is a delicious morsel which the Apache epicure seizes upon wherever possible. The stunted oak, growing on the mountain flanks, furnishes acorns; the Spanish-bayonet, a fruit which, when roasted in the ashes of a camp-fire, looks and tastes something like the banana. The whole region of southern Arizona and northern Mexico is matted with varieties of the cactus, nearly every one of which is called upon for its tribute of fruit or seed. The broad leaves and stalks of the century-plant—called *mescal*—are roasted between hot stones, and the product is rich in saccharine matter and extremely pleasant to the taste. The wild potato and the bulb of the *tule* are found in the damp mountain meadows; and the nest of the ground-bee is raided remorselessly for its little store of honey. Sunflower-seeds, when ground fine, are rich and nutritious. Walnuts grow in the deep ravines, and strawberries in favorable locations; in the proper season these, with the seeds of wild grasses and wild pumpkins, the gum of the *mesquite*, or the sweet, soft inner bark of the pine, play their part in staving off the pangs of hunger. The above are merely a few of the resources of the Apache scout when separated from the main command. When his moccasins give out on a long march over the sharp rocks of the mountains or the cutting sands of the plains, a few hours' rest see him equipped with a new pair—his own handiwork—and so with other portions of his raiment. He is never without awl, needle, thread, or sinew. Brought up from infancy to the knowledge and use of arms of some kind—at first the bow and arrow, and later on the rifle—he is perfectly at home with his weapons, and, knowing from past experience how important they are for his preservation, takes much better care of them than does the white soldier out of garrison. He does not read the newspapers, but the great book of nature is open to his perusal, and has been drained of much knowledge which his pale-faced brother would be glad to ac-

quire. Every track in the trail, mark in the grass, scratch on the bark of a tree, explains itself to the "untutored" Apache. He can tell to an hour, almost, when the man or animal making them passed by, and, like a hound, will keep on the scent until he catches up with the object of his pursuit.

The Pine Belt of New Jersey.—The "pine belt" of New Jersey is described by Dr. I. H. Platt as a strip of land about sixty miles long by from eight to twenty miles wide, reaching from a few miles south of Freehold almost to Vineland. Its soil varies from a light, sandy loam to clear beach sand. Its streams, which are sufficient for drainage, have good banks which they rarely if ever overflow, and there is no wet meadow. There are a few peat-bogs, some marl-beds, and occasionally a cedar swamp, but these features are all of very limited extent. The belt comprises in all about five hundred and seventy square miles, and has a population of 14,475 persons. The region has long enjoyed a local reputation for healthfulness, and some parts of it have been mainly settled by people who have sought it for that reason. According to the reports of the State Board of Health, its average death-rate during the six years, 1883 to 1888, inclusive, was 12·65 per thousand, against 18·65 per thousand for the whole State, or 15·07 for the State excluding cities; and the death-rate from consumption was 1·60 against 2·53 and 2·12. The comparatively low mortality from consumption is the more striking when we recollect the extent to which the region is sought by persons in feeble health.

The Mouth-slitting Botocudos.—A monograph on the Botocudos of Brazil and their ornaments has been published by Dr. John C. Branner, in a reprint from the papers of the American Philosophical Society. It is illustrated by photographs showing the manner of wearing the ear- and mouth-plugs from which the tribe derive their name (*botoque*, lip-ornament), the appearance of the slits when they have been torn, and the younger members of the tribe who have ceased to practice the mutilation, or have reduced it to the simple wearing of earrings. Mr. John Stearns said, in a paper before the Royal Geographical Society, on the Exploration of the Rio Doce and its Tributaries, that the custom of these Indians of slitting the lower lip for the purpose of inserting a wooden ornament in it has been described by visitors to the American coasts from Cabral down. When Cabral sent a boat ashore in Brazil to investigate the country, the men told him on their return that they did not believe the natives were men, though they were dressed up in feathers and painted in colors, for they had two mouths. The Indians were accustomed to take out the lip ornaments, and, while the teeth were grinning from the upper mouth, to push out the tongue from the lower one. Cook, two hundred and eighty years later, at Prince William's Sound, Alaska, heard one of his sailors say to another, "Come here, Jack, look at the men with two mouths." A writer of that period tells of the wife of a great chief at Sitka, that by a singular motion of the lower lip she could raise it in such a way as almost to cover the whole of her face. Mr. Colin Mackenzie has cursorily followed out the geographical line of this singular custom, and has found that it could be traced, with very few breaks, from Alaska to the coast of Brazil.

Medicinal Plants.—The pamphlet of Mr. Charles Mohr, on The Medicinal Plants of Alabama, besides the list of the plants, with notes on their distribution and the proper time of collecting the parts used, contains some facts of interest respecting the flora of the State and the home of its medicinal plants. The flora of Alabama includes a majority of the plants noted for their remedial value which are found in North America east of the Rocky Mountains. The plants furnishing drugs of the greatest importance have their home principally in the woodlands of deciduous-leaved trees in the northern section of the State. With the enormous decrease of the forest area north of the Ohio River that has taken place during the last thirty-five years, the supply of crude drugs furnished by that territory has been correspondingly reduced. The resources existing in the more elevated regions of the South have consequently been resorted to. Within the past ten or fifteen years North Carolina has become the center of the most active trade in this line, which is gradually

extending farther south, and operations have been successfully begun in the northern section of Alabama. This region offers a promising field for the enterprise, with the prospect of supplies to last for a long time to come. Particularly in the mountainous and hilly districts, extensive tracts, unfit for the cultivation of the soil, will probably remain, if not violently interfered with, in the condition of woodlands. "Thus we find the interest of the healing art closely connected with the question of the preservation of the forests of our country, and the pharmacist should feel in duty bound to unite his efforts with those who are already striving to secure this important object."

The Doctrine of Spirits in New Guinea.—The natives of British New Guinea, according to Mr. H. H. Romilly, believe that human appetites remain with the spirits of their deceased friends, just as if the body had not died. Hence the spirit must be kept supplied with food and water at the grave and in the accustomed haunts of the dead man. But if he has been killed in battle, the head of one of the enemy's tribe or race is sufficient; and if the slayer is a white man, the spirit can be appeased by payment in goods. They regard dreams as voices from the land of spirits, telling them what to do, for whom to work, from whom to plunder, and what to steal. When any mischief befalls a place where a white man happens to be, the blame is laid upon his attendant spirit, and the injury must be atoned for—by payment if he is a friend, or otherwise if not. Certain trees are supposed to have spirits, for which a part of the food or feasts is set away. It is noteworthy that all these spirits are malignant, and the savages do not seem able to grasp the idea of a beneficent spirit. They have to be overcome by force of arms, blessings, or cursings, but are most effectively dispelled by fire. They can not be seen, but use arrows and spears when they are vexed. Sorcerers are guarded against by wearing charms, the character of which is regulated largely by the fancy of the sorcerer or the purchaser. Sometimes the charm is a bit of bark, sometimes it is a fantastically worked crab's claw; but great faith is reposed in its potency.

Lepidosirens.—The *Dipnoi*, one of the oldest types of water animals, are now represented by only four species: *Lepidosiren paradoxa*, a very rare species inhabiting the river Amazon; two species of *Ceratodus* or *Barramunda*, plentiful in certain rivers of Australia; and *L. annectens*, which is the most abundant, being found throughout tropical Africa. The lepidosiren, or "African mud-fish," has a somewhat eel-shaped body and four limbs, which are round and taper to a point, being the simplest form of limb known. The breathing-organs consist of both gills and lung-like sacs; the skeleton is part cartilage and part bone; the nostrils, of which there are two pairs, are placed within the opening of the mouth. It is the organ of smell which determines that the lepidosiren is a fish and not a reptile. In every fish this organ is a short sac opening only upon the outer surface of the body; in every reptile it is a canal with both an external and an internal opening. Though lepidosirens are without doubt fishes, they spend a considerable part of their existence out of the water, as they inhabit shallow waters which periodically dry up. During the dry season they inclose themselves in balls of clay, which are lined with mucus, and have a small hole at each end to admit air. In these they remain torpid until the rains refill their pools. Lepidosirens attain a length of from three to six feet; they are carnivorous, feeding on frogs, fishes, and other aquatic animals.

Indian Tribes of the Amazon.—Of the Indian tribes of the Amazonian river Purus, the Pammarys are described by Dr. P. Ehrenreich as being pure water-men. Most of their life is spent in their canoes, and they are conspicuous by a peculiarity of their skin, which is covered with black and white spots that cause many of them to look as if they were dappled. The same skin affection exists among other tribes of the western Amazons, and is very mysterious. The Pammarys are industrious collectors of caoutchouc and copaiva, and have provided themselves with many European articles of commerce. The Jamamadis make their homes in the forests; are without a knowledge of navigation; are clever agriculturists; avoid trade with the settlers, and seldom leave their dense forests.

They are still an uncorrupted, hospitable, frank, natural people. Their principal weapon is the blow-pipe, discharging poisoned arrows. The most important nation on the Purus are the Ipurinas, or Cangiti, who dwell in numerous hordes, under different names, in the head-water regions. They are a proud, warlike race, of vindictive disposition, cunning, and treacherous. They are still partly anthropophagous. Domestic animals are rarely kept among them; tobacco is taken as snuff; and poisoned weapons are generally used. In the region of the source of the Rio Acre other Indian races of great interest to ethnologists dwell, possessing richly carved huts for ceremonies, stone figures, and idols. The caoutchouc trade, with its reckless gains, exercises a most disastrous effect upon the Indians; nevertheless, that element might become of the highest importance to the immense but thinly peopled province of the Amazon, if only a judicious and conscientious treatment was adopted as the means of bringing the aborigines within the bounds of civilization.

The Pallas Cormorant.—Pallas's Cormorant, or the great spectacled cormorant (*Phalacrocorax perspicillatus*), has gone to keep company with the great auk, as a bird that has become extinct within the last forty or fifty years. It is so rare in collections that only four specimens are known to exist in museums, no one has its eggs, and no bones had been found or preserved till Mr. Leonhard Stejneger collected a few of them some years ago on the Commander Islands. It was reported very abundant on Bering Island by Steller in 1741, and the only material for Pallas's description of it was derived from his observations. The specimens in the British, St. Petersburg, and Leyden Museums were obtained from a governor of Sitka, and these are all that are known to be in existence. Several pictures of the bird have been published. Mr. Stejneger was informed by the natives of Bering Island that the meat of this species was more palatable than that of its congeners, and was used as food in preference to any other. According to Steller, the weight of the cormorant varied from twelve to fourteen pounds, so that one bird was sufficient for three starving men of his shipwrecked crew. The value of the cormorant as food, and its sluggishness, contributed to its extermination. The bones found by Mr. Stejneger have been examined and described by Mr. Frederick A. Lucas; and a full account of them, with the history of the bird, is given in a reprint from the proceedings of the National Museum.

Relative Abundance of the Chemical Elements.—An estimate of the relative abundance of the chemical elements in the atmosphere, ocean, and that part of the crust of the earth which is accessible, has been made by Prof. F. W. Clarke. Separate calculations are made for the atmosphere and the ocean. The estimate of the constitution of the crust is made from the means of 880 analyses of volcanic and crystalline rocks from different places of the United States and Europe. Averaging the whole, the author finds oxygen constituting 49·98 per cent; silicon, 25·30 per cent; aluminum, 7·26 per cent; iron, 5·08 per cent; calcium, 3·57 per cent; and after these, in order, magnesium, sodium, potassium, hydrogen, titanium, carbon, chlorine, bromine, phosphorus, manganese, sulphur, barium, nitrogen, and chromium. Other substances are supposed to be present in less proportions than five one-hundredths of one per cent. The most surprising feature in the estimate is the relative abundance of titanium, which is placed before phosphorus, manganese, and sulphur. It is, however, rarely absent from the older rocks; is almost universally present in soils and clays; and is often concentrated in great quantities in beds of iron ore. Having no very striking characteristics and but little commercial importance, it is easily overlooked, and so has a popular reputation for scarcity which it does not deserve.

The Summit of Kilima-njaro.—The ascent to the summit of Kilima-njaro, the highest mountain in Africa, was accomplished by Dr. Hans Meyer in October, 1889. The base of the ice-cap of Kibo was reached at 18,270 feet above the sea. The upper part of this ascent was extremely toilsome, as the surface of the ice became increasingly corroded, taking the form which Gussfeldt, on Aconcagua, in Chili, called *nieve penitente*; honeycombed to a depth of over six feet,

in the form of rills, teeth, fissures, and pinnacles. The travelers frequently broke through as far as their breasts, with an alarmingly rapid diminution of their strength. Reaching the summit of the ridge, they found the precipitous walls of a gigantic crater yawning beneath them, with the loftiest elevations in the shape of three pinnacles rising above the ice on its southern brim. These they calmly and systematically climbed one after the other. The central pinnacle reached a height of about 19,700 feet, overtopping the others by 50 or 60 feet. Dr. Meyer was the first to tread this peak, and planted the German flag upon it, christening it Kaiser Wilhelm's Peak. The diameter of the crater measured about 6,500 feet, and its depth was about 600 feet. In the southern portion the walls of lava were of an ash-gray or reddish-brown color, and were free from ice; in its northern half the ice sloped downward from the upper brim of the crater in terraces, forming blue and white galleries of varying steepness. A rounded cone of eruption, composed of brown ashes and lava, rose in the northern portion of the crater to a height of about 500 feet, which was partly covered by the more than usually thick sheet of ice extending from the northern brim of the crater. The large crater opened westward in a wide cleft, through which the melting water ran off, and the ice lying upon the western part of the crater and the inner walls issued in the form of a glacier.

Artists in Humble Work.—Among the ancient Greeks and the northern Italians of Renaissance days, says Prof. G. Aitchison, in a lecture on Decoration, beauty was adored. Every man who practiced a craft was as sure of fame, if he followed what we now call a humble one, as if he followed a noble one, provided that the articles he made could be endowed with beauty, and that he possessed a certain high degree of excellence. A carpenter, an armorer, a potter, a goldsmith, a lapidary, or a bronzer, was as certain to be famous as a sculptor, a statuary, a painter, or an architect. "We naturally know less about the ancient Greeks than about the Italians, though, from Socrates being a sculptor, we hear something of the crafts, and we know that Phidias was not only a sculptor and statuary, . . . but worked also in ivory and gold. The great Italian artists were almost invariably craftsmen as well; in fact, had begun as craftsmen and had learned during their apprenticeship precision in the use of tools and in workmanship as well as precision in drawing and modeling. As a rule, every youth who wanted to be a painter, sculptor, or architect, was apprenticed to a goldsmith. Brunelleschi, Michael Angelo, and Benvenuto Cellini were all brought up as goldsmiths; one became an architect, one a sculptor and painter, and one a statuary and die-sinker; Ghirlandaio got his name from the golden wreaths he made, and Francia . . . signed his pictures as a goldsmith, while he signed his goldsmith's work as a painter, and, like the French artists of the present day, these artist craftsmen were often excellent shots and swordsmen as well. If he can invest the article he works at with the highest form of beauty, he is just as much an artist as he who paints a picture, models a statue, or designs a building."

Messrs. Heilprin and Baker's Survey of Mexico.—Prof. Angelo Heilprin and Mr. Frank C. Baker have recently returned from a scientific expedition to Mexico, which they undertook in February, 1890, in connection with the Academy of Natural Sciences of Philadelphia, and are preparing a paper giving the results of their explorations. It is represented that the main purpose of the expedition—the determination of the physical relations of the Gulf border—was successfully accomplished. The principal volcanoes—Orizaba, Popocatepetl, and Ixtaccihuatl—were ascended; and more exact measurements than have been made before gave Orizaba as the highest of the three, at a little less than eighteen thousand feet, instead of Popocatepetl. An entirely new view is taken by the explorers of the structure of the great central plateau. Instead of being an integral part of the Cordilleran system or a volcanic output, it is mostly a flooded expanse of lava and ash, which has covered over the Cretaceous system of rocks and mountains that constitute a nucleus to the plateau. Immense deposits of fossiliferous limestone, manifestly a part or continuation of the Cretaceous system of the United States, crop out around the borders of the

plateau, and at points within the same, capped by the covering of lava and ash. The explorations of Yucatan did not lend support to the supposition that the banks have been built up through simple organic accretion. The evidences of recent uplift were abundant, and it further appeared that a gradual subsidence followed the elevation.

Geometry of Aboriginal Mounds.—In his paper on the Circular, Square, and Octagonal Earthworks of Ohio, Mr. Cyrus Thomas gives the results of recent surveys of those works, and corrects the errors into which Squier and Davis fell in exaggerating the geometrical accuracy of the structures. The close approximation to such regularity in certain of the square and circular works is admitted as beyond question; but none of them are perfect, while the octagons are less regular. Their characteristics are pronounced essentially aboriginal. There is nothing in them or connected with them contradictory to the theory of their Indian origin except it be the single fact that a few of them approached very nearly to true geometrical figures. It is admitted both that Indians can lay out true circles of moderate size, and that they are less able now to perform many things which necessity formerly compelled them to practice. No valid reason can be presented why Indians taught by necessity and practice could not lay off by the eye and by means at hand figures with which they were familiar more correctly than the white man without instruments.

An Indian Ball-Player's Training.—As described by Mr. James Mooney, the training of the Cherokee ball-players includes a course of precautionary measures. "They bathe their limbs with a decoction of *Tephrosia Virginiana*, or catgut, in order to render their muscles tough like the roots of that plant. They bathe themselves with a decoction of the small rush (*Juncus tenuis*), which grows by the roadside, because its stalks are always erect and will not lie flat upon the ground, however much they may be stamped and trodden upon. In the same way they bathe with a decoction of the wild crab-apple, or the iron-wood, because the trunks of these trees, even when thrown down, are supported and kept from the ground by their spreading tops. To make themselves more supple, they whip themselves with the tough stalks of the *sdtaka*, or star-grass, or with switches made from the bark of a hickory sapling which has grown up from a log that has fallen across it, the bark being taken from the bend thus produced in the sapling. After the first scratching the player renders himself an object of terror to his opponent by eating a rattlesnake which has been killed and cooked by the shaman. He rubs himself with an eel-skin to make himself slippery like the eel, and rubs each limb down once with the fore and hind leg of a turtle, because the legs of that animal are remarkably stout. He applies to the shaman to conjure a dangerous opponent so that he may be unable to see the ball in its flight, or may dislocate a wrist or break a leg. Sometimes the shaman draws upon the ground an armless figure of his rival with a hole where the heart should be. Into this hole he drops two black beads, covers them with earth, and stamps upon them, and thus the dreaded rival is doomed, unless (and this is always the saving clause) his own shaman has taken precautions against such a result, or the one in whose behalf the charm is made has rendered the incantation unavailing by a violation of some one of the interminable rules of the *gukhwnta*."

NOTES.

Prof. Huxley was the recipient of the Linnæan medal at the anniversary meeting of the Linnæan Society on Saturday, May 24th. This medal was instituted three years since, with a view of conferring honor on distinguished biologists. In replying to the president, Prof. Huxley said the aim of his life had been in the words of the motto of the society: "Naturæ discere mores" (to learn the ways of nature). He had endeavored to show the fundamental unity of plant life and of animal life; to make use of hypotheses as ladders or scaffoldings to be discarded, perhaps somewhat ungratefully, when no longer of use; and to pursue truth regardless of incidental consequences.

In order to investigate their botanical and medical knowledge, and the theories on which their practice is based, Mr. James Mooney spent several weeks in intimate association with the Cherokee doctors. He concluded that the aggregate botanical knowledge of the whole profession is represented by about eight hundred species;

but no one doctor knew the names of three hundred species. Many of the most common plants and brightest flowers have no Cherokee names for the Indians do not use them for food or medicine. Yet their country—the mountain region of western North Carolina—can probably furnish two thousand species of plants. The Indian has no appreciation of the beauty or fragrance of a flower.

An extract from a lecture by J. Lewis Smith, M. D., of Bellevue Medical College, on Growing Pains, contains some very valuable cautions. He says the pains in the limbs experienced by many children, and attributed to rapid growth, are very commonly slight attacks of inflammatory rheumatism, a dangerous and painful disease when occurring in an adult.

The practice of cremation in place of ordinary burial is making steady progress in Paris, in spite of the opposition to it which exists in certain quarters. At the new crematorium of the cemetery "Père-la-chaise" a furnace is in operation which will reduce a body to ashes in less than an hour, at a cost of about thirty cents for fuel. Since the establishment of this system in the French capital twelve hundred unclaimed bodies of persons who have died in hospitals have been thus disposed of, besides the bodies of three hundred of the well-to-do classes, whose wishes have been thus complied with.

A description is published by T. H. Lewis of the sculptured figures on a rock of the Potsdam sandstone on the bank of the Trempeleau River, near Trempeleau, Wisconsin. The figures consist chiefly of representations of the hand and foot many times repeated, crescent-shaped figures called canoes, and what appears to be a fort. They are cut very smoothly into the rock to the depth of from a quarter of an inch to an inch, and are in perfect preservation.

A mixture of sixty parts of chloride of sodium and forty parts of cryolite or double fluoride of aluminum and sodium having been melted at a temperature of from 850° to 1,100° C., was submitted to electrolysis by M. Minet. Metallic aluminum flowed out of the cathode, which was in charcoal, into a crucible, whence it was extracted at the close of the operation. The author produced in this way, in twenty-four hours, 5,250 grains of metallic aluminum.

Prof. Arthur Dodel, of the University of Zurich, says that he has observed, of his students in botanic microscopy, that the average of those from America drew better than those from Europe of the same age who competed with them. To this he would add the circumstance that in America, during the last two years, the technique of reproduction has made more progress than in any other part of the world. For the cause of this excellence, Prof. Dodel refers to the method of the instruction in drawing in the primary and intermediate schools. "It will not be surprising," he adds, "if this vigilant nation finally surpasses us, and also puts us in the shade in the field of artistic painting and sculpture. This I call an enjoyable danger, and greet it in advance in the interest of the general welfare of humanity."

The commission appointed to consider the question of coal-waste in the State of Pennsylvania has sent out a circular of inquiries on topics relating to the investigation it has undertaken. The questions come under three categories, of Geological and Statistical Waste, Waste of Producing and Marketing, and Utilization of Coal Waste. Under the first head are questions relating to the amount, annual production, and natural wastes of the coal-beds. The second heading includes the waste incurred in preparing the coal for market, the amount of culm, etc. The third head embraces the Briquette system of preparing the waste for use; the appliances by which it is utilized without mechanical preparation; and the gasifying processes and use in the destruction of garbage or cremating work, and in agricultural experimentation.

Mr. David P. Todd, of the Smithsonian Institution, has made a report of progress in an investigation in which he is engaged of the variations of the elements of terrestrial magnetism. Since the demonstration that the direct influence of the sun and the moon upon the earth, each being considered as magnets, is inappreciable, all attempts to construct a theory of terrestrial magnetism have been confined to causes within the earth's atmosphere. These efforts—the aim of which has been to constitute currents by friction in the earth's crust, or in the atmosphere by changes of density and humidity—have failed to account for the periodic nature of the phenomena. Consequently, the vast masses of magnetic observations already accumulated are unconnected by any proposed combination of natural laws. It appears, however, that one cause of vital importance has been omitted from the elements of the problem, namely, the motion of the earth, as referred to the ether in its neighborhood; and the author proposes to base an explanation of terrestrial magnetism upon the dynamic effects produced by the inductive action of the earth in its motions of rotation and translation through fields of force—or, by regarding the earth as a cosmical dynamo.

Some new and remarkable results are described by M. Friedel as following the action of alkalies and alkaline silicates on mica under the double influence of water and a high temperature. With potash and the brown mica called muscovite, numerous crystals of

nephiline were prepared—a mineral which had never before appeared from manipulation with water. Better success was had when soda was substituted for potash; and in every case a product of simple and fixed composition was obtained. Adding a suitable proportion of chloride of sodium, sodalite was formed, and proved to be of definite composition, and not, as some mineralogists believed, a mixture of nephiline and an alkaline chloride. With mica and silicate of potash crystalline orthose feldspar was obtained, and, with a smaller proportion of silicate, amphigene. The intervention of chloride of calcium determined the crystallization of anorthite.

In view of the greatly augmented demand for camphor for the new uses that have been found for it in the arts, with consequent enhancement of price, it is proposed to use naphthalin as a substitute for it in anti-moth applications. It is quite as effective as camphor, and being also equally volatile, leaves no more permanent smell.

Mr. E. T. Chaplin tells, in the London Spectator, how, by hypnotizing her, he induced a laying hen, which had manifested no disposition in that direction, to sit on a sitting of eggs till seven of their number were hatched into "healthy, happy little chickens."

Bisulphide of carbon is recommended by Mr. A. J. Cook, of the Michigan State Agricultural Experiment Station, as one of the very best insecticides. It has been used with success to destroy the phylloxera on the grape-vines of France; is applied to the destruction of prairie-dogs in the West; and has been used by Mr. Cook with success to destroy ants. A single dose in the habitation of the animal, or in an apartment, is usually sufficient. It is exceedingly volatile, and its vapor reaches everywhere. But it must be used with great care, for the vapor is very inflammable and poisonous; so that a room in which it is used must be well aired before one enters or carries a light into it.

A considerable portion of the Second Annual Report of the Maryland Agricultural Experiment Station is devoted to the tomato. The record of the experiments with this fruit is preceded by a valuable paper on the history of the tomato, by Dr. E. Lewis Sturtevant.

A quick and easy method for determining whether or not a fabric is "all wool" is given in the Lancet. This is to separate the warp from the woof, and to hold each to a flame. Wool burns into a shapeless mass, and no threads can be traced in its ash. If removed from the fire before it is all burned, it ceases to blaze; cotton, on the contrary, continues to burn steadily, and its ash retains the shape of the thread.

A redwood-tree, ninety feet in circumference and thirty-three feet in diameter, is being cut for the Chicago exhibition. The section to be sent to Chicago will be nine feet in height and sixty feet in circumference, and will weigh sixty-five thousand pounds. The tree is taken from the forests of Tulare County, California.

OBITUARY NOTES.

Prof. C. H. F. Peters, Director of the Litchfield Observatory of Hamilton College, Clinton, N. Y., died July 19th, in his seventy-seventh year. He was a native of Sleswick, and had been in the observatory directorship more than thirty years. He was the discoverer of forty-seven asteroids, his last discovery in that line being that of Nephthys, in August, 1889. He was chief of the party which observed the total eclipse of the sun at Des Moines, Iowa, August 7th, 1869; and also of the party that observed the transit of Venus in 1874 in New Zealand.

Charles Grad, an eminent Alsatian student of science, died at Logelbach, July 5th, in the forty-eighth year of his age. He was one of the earliest contributors to *La Nature*, and continued his active relations with that journal as long as his health permitted. His first scientific papers were in geology. Many of his contributions related to Alsatian matters of scientific interest.

William Kitchen Parker, an eminent English biologist, died suddenly in Cardiff, Wales, July 3d. He was drawn to the study of nature and to experimenting on plants and animals at a very early age; was the author of a number of valuable papers (1856–1873) on foraminifera, and made communications to the Zoölogical and Royal Societies on birds and animals, his last work, on The Duck and the Auk, having been published in the present year. He was a member of several scientific societies, British and foreign; was for many years a Hunterian Professor at the Royal College of Surgeons; and was the author of books on the Morphology of the Skull and on Mammalian Descent. Two of his sons are Professors of Biology, at Cardiff and in Otago, New Zealand.

The death is announced of Alexander von Bunge, Professor of Botany in the University of Dorpat, at the age of eighty-seven years. He made a scientific voyage to China in 1830; and was principally interested in the flora of Russia and northern Asia.

M. Alphonse Favre, formerly Professor of Geology at Geneva, has recently died, seventy-seven years old.

M. Paul Loye, who recently died in France, was the author of a memoir on the physiology of death by decapitation, and had published short notes on physiological questions.

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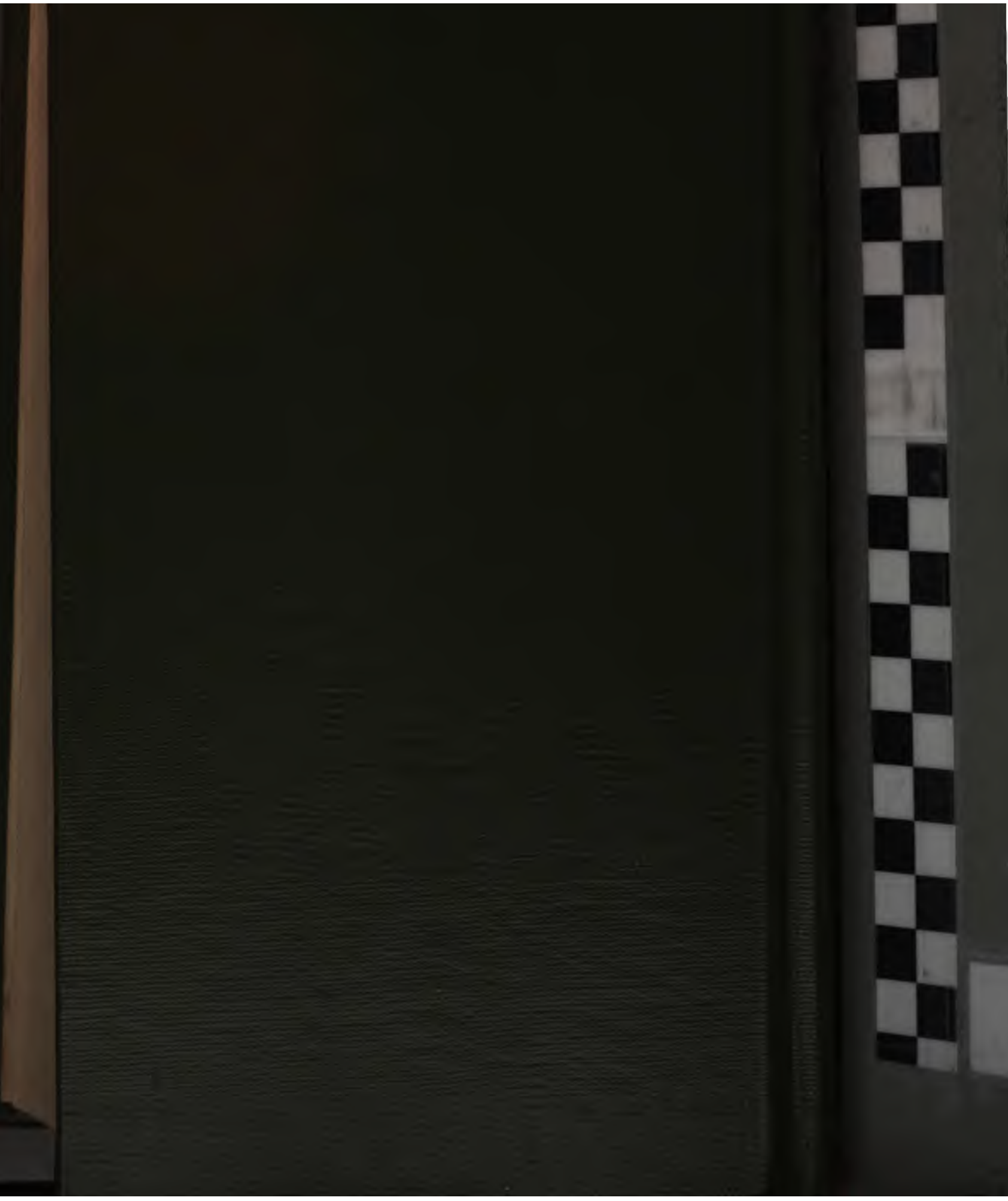
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